ORIGINAL RESEARCH ARTICLE

Health Program and Nutritional Determinants of Pregnancy Anemia in Boyolali District, Central Java, Indonesia: A Case-Control Study

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ABSTRACT

Background: Pregnancy anemia is a significant issue in Indonesia's public health. The modifiable risk factors of pregnancy anemia were nutritional and health program factors. This research examines the determinants of pregnancy anemia in individual and nutritional health program factors in Boyolali Regency, Central Java Province, Indonesia.

Methodology: This facility-based case-control study was conducted in three areas of Primary Healthcare Centers. The case was 60 pregnant women whom health providers diagnosed as having anemia, and the control was 60 who did not.

Results: Bivariable analysis showed that the associated factors of pregnancy anemia were parity, family wealth index, maternal health literacy, antenatal care (ANC) compliance (six visits), and Iron-Folic Acid (IFA) consumption. Meanwhile, variables that were not significantly related were birth interval, gravida, monthly expenses, and daily iron intake. Multivariable analysis showed that pregnant mothers who did not followed the recommended ANC were 14.4 times more likely to experience pregnancy anemia than those who did (p-value <0.0001). Irregular IFA consumption, wealth index and parity were also significant determinants of pregnancy anemia.

Conclusions: Following health programs, such as attending ANC and IFA consumption, significantly reduces the risk of pregnancy anemia. Health providers should encourage pregnant women to achieve the recommended six ANC visits.

Keywords: Case-control, IFA supplementation, K6 ANC visit, Pregnancy anemia

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INTRODUCTION

Anemia is a significant public health issue in developing countries, particularly in Indonesia, where pregnant women are most vulnerable. The World Health Organization (WHO) estimates 37% of pregnant women suffer from anemia, with Africa and South-East Asia being the most affected regions.[1,2] The prevalence of anemia in Asia is 40%.[3] Iron deficiency anemia is the most common cause, leading to increased maternal morbidity - mortality, premature birth, low infant birth weight, and infant death.[4–6]

As per WHO recommendations, Indonesia has implemented various efforts to prevent anemia, including nutritional counseling and iron and folic acid supplementation during antenatal care.[7,8] However, the incidence of anemia during pregnancy in Indonesia was high at 48.9%, according to Indonesia Basic Health Research data in 2018.[9] WHO recommends countries that have a prevalence of anemia in pregnant women of more than 40 percent must be addressed immediately.[1]

Anemia is influenced by nutritional, dietary, individual, and socioeconomic factors. Nutritional factors, such as Fe-containing food intake, daily meal frequency, food diversity, and meat consumption, are associated with anemia incidence.[10] Individual factors like parity, gravida, and birth interval also contribute to anemia.[11] Studies on prevalence of anemia rarely use the wealth index as a proxy for socioeconomic status. This study introduces it as a different approach.[12–14] Additionally, while maternal health literacy is linked to pregnancy complications, its association with anemia remains underexplored, particularly in Indonesia.[15] Most studies on this topic comes from developed countries. This study addresses these gaps by examining both socioeconomic status (using the wealth index) and maternal health literacy in relation to anemia in pregnancy within the Indonesian context.

Health program factors such as the routine consumption of IFA tablets and the frequency of Antenatal care (ANC) that follows government standards were also related to anemia.[13] In 2021, the Indonesian government issued a new policy on ANC service, Integrated Antenatal Care. It also renewed the recommendation of minimum ANC visits, K6 ANC visits, which were six times: once in the first trimester, twice in the second semester, and three times in the third trimester. It included two visits with specialist physicians.[8] These latest standards concerning pregnancy anemia have not been widely studied.

The study focuses on the prevalence of anemia in the Boyolali region of Indonesia. Based on the data, the Boyolali region has several areas with the highest prevalence of anemia at 33.65%.[16] Hence, this study intends to examine the determinants of pregnancy anemia among individual factors (gravidity, parity, birth interval, maternal health literacy, family welfare level), health program factors (IFA Supplementation and ANC compliance), and nutritional factors, namely dietary iron intake in the Boyolali regency, Central Java Province, Indonesia.

This study intends to examine the determinants of pregnancy anemia among individual factors (gravidity, parity, birth interval, maternal health literacy, family welfare level), health program factors (IFA Supplementation and ANC compliance), and nutritional factors, namely dietary iron intake in the Boyolali regency, Central Java Province, Indonesia.

METHODOLOGY

This facility-based case-control study was conducted in three areas of Primary Healthcare Centers: Juwangi, Musuk, and Wonosegoro, from January to June 2023. This case population was pregnant women diagnosed with anemia by health providers and attended antenatal care in the three primary healthcare centers of 98 women. Women in the first and third trimesters with Hb levels of 11g/dl and women in the second trimester with Hb levels of 10.5 g/dl were considered anemia. The study included pregnant women of any gestational age (GA). This selection ensures an adequate sample size from the targeted healthcare centers while accounting for the time required for data collection. Additionally, previous studies suggest that including all GA provides a comprehensive analysis of anemia risk factors without restricting insights to a specific pregnancy stage, ensuring the findings are more applicable to a broader population of pregnant women.[17] GA in pregnant women was divided into trimesters: GA less than 12 weeks: first trimester, GA 13-24 weeks: second trimester, and GA greater than 24 weeks: third trimester. The sample criteria were pregnant women who had a complete medical record on the Maternal and Child Health book (Buku KIA) and did not have a history of diseases such as HIV / AIDS and Malaria. The minimum sample size was calculated using OpenEpi Websites using unmatched Case Control Formula in 95% Confident Interval, power of 80%, 1:1 case: control ratio, and P2 value of 0.10 and OR value of 4.21.[18] The minimum sample was 50. In total, 60 pregnant women were willing to participate as participants; they were defined as a case group. The control group was selected from the list of Antenatal Care visits from March to June 2023 from the three Primary Healthcare Centers of 411 women not diagnosed with anemia. Of the total, 60 respondents were selected using a systematic random sampling technique. The right of participants to refuse to participate or withdraw at any time during the interview was guaranteed. To protect confidentiality, all information acquired from study participants was coded.

Ethical Considerations: The study was conducted after being ethically evaluated and approved by the Faculty of Medicine, Universitas Muhammadiyah Surakarta Research and Ethical Review Committee

number 4953/B.2/KEPK-FKUMS/VIII/2023. Then, an official letter of cooperation was written, and approval was acquired from the chosen Primary Healthcare Centers.

Data Collection and Measurement: Data collection was carried out using self-administered questionnaire techniques. The questionnaire was developed based on a literature review to collect data on individual factors, ANC Compliance, and IFA consumption. The 30 Cepogo Primary Healthcare Center respondents tested all the questionnaires for validity and reliability. ANC compliance was measured using seven items. ANC compliance is categorized as following K6 visits if following the particular rule of ANC visits: at least once visit the specialist physicians in the first trimester, twice in the second semester, and three times in the third trimester with at least one visit to the specialist physicians. Iron and Folic Acid (IFA) consumption was measured using four items asking about IFA consumption within the last week and categorized as regular if at least four tablets were consumed weekly. The Cronbach alpha value for the ANC compliance and IFA consumption questionnaire was 0.636.

The family welfare level questionnaire is adapted from the National Population and Family Planning Board questionnaire, which consists of 5 classifications and 21 question items. The five classifications are the pre-welfare families, welfare family level 1, welfare family level 2, welfare family level 3, and welfare family level 3 plus. Respondents were categorized as a pre-prosperous family if they had the pre-welfare families or welfare family level 1 and a prosperous family if they had welfare family level II, III, or III Plus.[19]

Maternal health literacy questionnaires were adapted from the *Maternal Health Literacy Inventory in Pregnancy* (MHELIP).[20] The 47-item questionnaire was translated and tried out of 30 pregnant women. The Cronbach alpha value obtained was 0.966. MHELIP score is classified into five categories, namely insufficient (score of 0 – 50), problematic (50,1 – 66), sufficient (66,1 – 84), and excellent (84,1 – 100). This study categorized maternal health literacy as insufficient (0-66) and adequate (66.1-100).

The dietary iron intake was measured using a semi-quantitative food frequency questionnaire for iron-rich food that was adopted from IRONIC-FFQ.[21] Pilot study was conducted among 30 pregnant women in the Cepogo Primary Health Care Center area to ensure its suitability for local dietary patterns. Four items that were not common to Indonesian food culture were removed from the original list. The final list of food items (n = 166) included in this was categorized into eleven food groups: meat, meat products, egg, dairy products, fish, staples food, cereal products, fruits, green leafy vegetables, drinks (including FE absorption modifier), and snacks. The four frequency options are "daily," "weekly," "monthly," and "never." Participants were asked to record their food consumption frequency and quantity over the previous months. The information was gathered through interviews done by trained enumerators. The item and list of food interview results were calculated using the Nutri Survey, and the results of this calculation further in the search for the average value of every food and drink consumed by a pregnant woman for the last month. Dietary iron intake is then categorized below and above the Recommended Dietary Allowance (RDA) based on the 2019 Indonesian Recommended Dietary Allowance Table, considering the respondent's age and gestational age.[22]

Statistical Analysis: Univariable analysis was performed on each variable, yielding proportionate findings. Bivariate analysis was performed using Chi-square, and the results revealed a relationship between each independent variable and the dependent variable; statistical significance was determined if the p-value was less than 0.05. Multiple logistic regressions with purposeful selection modeling yielded multivariate results in the search for significant determining factors of pregnancy anemia. The selection of variables in the final model for the multivariable analysis was constructed based on the theory or literature review and multicollinearity between a group of independent variables. In the multicollinearity analysis, some variables had a significant association with other independent variables. Among all, maternal health literacy was associated with ANC compliance. Respondents with sufficient maternal health literacy were more likely to follow the recommended ANC. Therefore, the association of maternal health literacy with pregnancy anemia can be predicted from ANC compliance, and it was excluded from the model. The final model's selection was based on the highest Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC), and Pseudo R2 values. The model was developed to predict the effect of the variables controlled by other variables, shown by the Adjusted Odd Ratio (AOR) value in a 95% confidence interval (CI). The Hosmer-Lemeshow goodness of fits test determines the multivariate model's quality.

RESULTS

All 120 participants (60 with anemia and 60 controls) completed all study components. The majority (68.3%) of the anemia group and 76.7% of the control group were experiencing a second pregnancy or more. At the time of the study, most respondents were in the third trimester (above 24 weeks of gestational age). Participants' mean (± standard deviation) age was 28.15 ± 6.21. Fifty-one percent of participants in the anemia group and 50% of controls had finished high school education. Meanwhile, most of husbands were also high school graduates, but the proportion was lower, 45% in the case group and 35% in the control group. The occupational status of the majority of participants was home-maker while, the majority of husbands work as merchants.

Table 1: Characteristics of the case and control group

Variable	Anemia (%) (n=60)	Non-anemia (%) (n=60)	*p-value*
Age, years			
16-25	24 (40)	23 (38.33)	
26-35	28 (46.67)	30 (50)	0.925
36-45	8 (13.33)	7 (11.67)	
Trimester			
Trimester 1	2 (3.33)	4 (6.67)	0.381
Trimester 2	20 (33.33)	25 (41.67)	
Trimester 3	38 (63.33)	31 (51.67)	
Gravidity			
Primigravida	19 (31.67)	14 (23.33)	0.307
Multigravida	41 (68.33)	46 (76.67)	
Parity			
Nulliparous	21 (35)	14 (23.33)	0.001
Primipara	21 (35)	8 (13.33)	
Multipara	18 (30)	38 (63.33)	
Mother's Education			
Elementary school	7 (11.67)	11 (18.33)	0.678
Junior high school	19 (31.67)	15 (25)	
High school	31 (51.67)	30 (50)	
Higher education	3 (5)	4 (6.67)	
Mother's Work			
Not Working	45 (75)	49 (81.67)	0.375
Work	15 (25)	11 (18.33)	
Husband's Education			
Elementary school	10 (16.67)	13 (21.67)	
Junior high school	21 (35)	23 (38.33)	0.698
High school	27 (45)	21 (35)	
Higher education	2 (3.33)	3 (5)	
Husband's Work			
Not Working	2 (3.33)	0 (0)	0.626
Laborer	20 (33.33)	18 (30)	
Farmer	5 (8.33)	4 (6.67)	
Merchant	19 (31.67)	21 (35)	
Employee	14 (23.33)	17 (28.33)	

As shown in Table 2, most of the case group's monthly expenses were below Rp 2,000,000. Meanwhile, 60% percent of the control group's expenditures were in the range of Rp2,000,000-Rp5,000,000. Most of the case group was categorized as a low-income family, while most control group was classified as Prosperous family level 3 and 3 plus. About 80% of the anemia group did not follow the recommended K6 ANC visit, while 71.67% of the non-anemia group followed the recommendation. Based on maternal health literacy, most respondents in the anemia group had problematic maternal health literacy. Meanwhile, the majority of the non-anemia group had sufficient scores. Bivariate analysis was performed to compare the characteristics between the case and control groups, ensuring no significant differences between groups. The results indicated that there were no significant differences in characteristics, including gestational age, between the two groups. However, parity showed a statistically significant difference and was therefore included in the multivariable analysis.

Based on the result of the SQ-FFQ iron source of food, it can be seen that the mean of the daily dietary iron intake in the last month among the anemia group was 16.68 (±14.75) g, and the non-anemia group was 14.78(± 13.77) g. Most respondents (80% of the anemia group and 81% of the non-anemia group) had daily dietary iron intake above the recommended level. Table 3 shows the most consumed heme-iron source foods: omelets, meatballs, and milk formulated for pregnant mothers (formula). The non-heme source food the respondent most consumed was local Indonesian food, namely tofu, tempe, and spinach soup. Respondents mostly had habits of consuming some tannins, oxalates, and phytates, namely tea, corn, tofu, sweet potato, and peanuts. Unfortunately, respondents habitually drink tea after consuming heme iron.

Table 4 depicts the bivariate analysis of the factors that contribute to anemia. It is observed that parity (OR 4.03 (1.88-8.63)), family welfare index (OR 4.36 (2.02-9.42)), ANC compliance (OR 10.11 (4.34-23.57)), IFA consumptions (OR 11.34 (3.48-36.94)), and maternal health literacy (OR 8.31 (3.65-18.87)) were the determinants of pregnancy anemia. Birth interval, gravida, monthly expenses, and daily iron intake were not significantly related variables.

The final model of pregnancy anemia determinants is available in Table 5. The probability of finding respondents with anemia was fourteen times higher if the respondents did not follow the recommended ANC visit with OR 14.35 95% CI (4.51- 45.63). Moreover, respondents with irregular IFA consumption were eleven times higher in the risk of pregnancy anemia with OR 11.34 (95% CI 3.48-36.94).

Table 2: Univariable analysis of case and control

Variable	Anemia (%) (n=60)	Non-anemia (%) (n=60)
Expenses (per month)		
<IDR 2 million	30 (50)	23 (38.33)
Rp 2-5 million	28 (46.67)	36 (60)
>Rp 5 million	2 (3.33)	1 (1.67)
Family welfare index		
Pre-prosperous	38 (63.33)	18 (30)
Prosperous level 1	5 (8.33)	4 (6.67)
Prosperous level 2	2 (3.33)	4 (6.67)
Prosperous level 3	7 (11.67)	14 (23.33)
Prosperous level 3+	8 (13.33)	20 (33.33)
ANC Compliance		
Did not Follow K6 visit	48 (80)	17 (28.33)
Follow K6 visit	12 (20)	43 (71.67)
IFA consumption		
Irregularly	38 (82.61)	8 (17.39)
Regularly	22 (29.73)	52 (70.27)
Maternal Health Literacy		
Insufficient	17 (28.33)	6 (10)
Problematic	26 (43.33)	8 (13.33)
Sufficient	13 (21.67)	31 (51.67)
Excellent	4 (6.67)	15 (25)
Daily iron intake, grams		
Mean ± SD	16.68 ± 14.75	14.78 ±13.77
Min-Max	1.94 - 77.9	2.15 - 57.3
Above RDA	48 (80)	49 (81.67)
Below RDA	12 (20)	11 (18.33)

Note: ANC: Antenatal Care; IFA: Iron and Folic Acid; RDA: Recommended Dietary Allowance; SD: Standard Deviations

Table 3: List of iron-source food and iron inhibitors consumed by the respondents

Rated leading five food source of heme iron	Rated leading five food source of non-heme iron	Iron Inhibitors
Omelet	Stir-fried tofu	Tea
Meatball	Fried Tempe	Corn
Pregnancy Milk	Spinach soup	Tofu
Fried chicken	Stir-fried papaya leaf	Sweet potato
Fried Nile Fish	Stir-fried water spinach	Peanuts

A parity of 0-1 also increased the risk of anemia four times more with OR 4.80(95% CI 1.47-15.58). The respondent lives in an unwealthy family wealth index also had higher risk of anemia during pregnancy. The quality of the model in predicting pregnancy anemia resulted from the pseudo-R2 value of 0.462. This model explained about 46.2% of the variation in pregnancy anemia. Besides, the Hosmer-Lemeshow goodness analysis of fits test with a p-value of 0.968 (>0.05) concluded that this model had good calibration and gave the correct prediction about the determinant of pregnancy anemia.

Table 4. Bivariable analysis of determinants of pregnancy anemia

Variable	Anemia (%) n=60	No anemia (%) n=60	p-value	COR* 95%CI
Gravidity				
Primigravida	19 (31.67)	14 (23.33)	0.308	1.52(0.68-3.41)
Multigravida	41 (68.33)	46 (76.67)		1
Parity				
0-1	42 (70)	22 (36.67)	<0.001	4.03(1.88-8.63)
≥2 ref	18 (30)	38 (63.33)		1
Birth Interval				
< 2 years	25 (53.19)	22 (46.81)	0.575	1.23(0.59-2.57)
≥ 2 years	35 (47.95)	38 (52.05)		1
Expenses (per month)				
< IDR 2.000.000	30 (50)	23 (38.33)	0.734	0.65(0.01-7.64)
Rp2.000.00-Rp5.000.000	28 (46.67)	36 (60)	0.45	0.39(0.03-4.51)
>Rp5.000.000	2 (3.33)	1 (1.67)		1
Family welfare index				
Unwealthy	43 (66.15)	22 (33.85)	<0.001	4.36(2.02-9.42)
Wealthy	17 (30.91)	38 (69.09)		
ANC Compliance				
Did not Follow K6 visit	48 (80)	17 (28.33)	<0.001	10.11(4.34-23.57)
Follow K6 visit	12 (20)	43 (71.67)		1
IFA consumption				
Irregularly	34 (56.67)	8 (13.33)	<0.001	11.34(3.48-36.94)
Regularly	26 (43.33)	52 (86.67)		1
Maternal Health Literacy				
Insufficient	43 (75.44)	14 (24.56)	<0.001	8.31(3.65-18.87)
Sufficient	17 (26.98)	46 (73.02)		1
Daily iron intakes				
Above RDA	48 (80)	49 (81.67)		1
Below RDA	12 (20)	11 (18.33)	0.817	0.89(0.36-2.23)

Note: *COR: Crude Odd Ratio; CI: Confident Interval

Table 5. The final model of multiple logistic regressions analysis determinant of pregnancy anemia*

Variable	Beta	P-value	AOR (95%CI)
Irregularly IFA Supplement Consumption	4.03	<0.001	11.34(3.48-36.94)
Do not follow the recommended ANC	4.52	<0.001	14.35(4.51-45.63)
Unwealthy of Family Wealth Index	2.02	0.043	3.19 (1.03-9.87)
Parity of 0-1	2.61	0.009	4.80 (1.47-15.58)

Note: * Model quality based on value of pseudo R^2 value= 0.462; AIC value= 99.51; BIC=113.46

DISCUSSION

The main findings of this study were ANC compliance, IFA consumption, family wealth index and parity, which significantly determined pregnancy anemia. Meanwhile, birth interval, gravida, monthly expenses, and daily iron intake were insignificant. This study emphasizes that compliance with the recommended six ANC visits was the strongest predictor of anemia during pregnancy. This study supports previous findings that prove the frequency of ANC is associated with pregnancy anemia.[2,23] A prior study in Indonesia found that women who followed the six ANC visits had a lower risk of maternal emergencies, including emergencies due to anemia.[24] Antenatal care helps prevent anemia by health professionals' support in motivating pregnant women to consume iron-rich foods and iron-folic acid tablets. The more

ANC visit increases the likelihood of women getting various counseling to prevent anemia. The previous studies found that the prevalence of anemia was lower in participants who had nutritional education.[25] The more often pregnant women have ANC counseling, the more information and advice they get about the consumption of IFA supplements and nutrition related to iron-rich food sources. This can increase their level of knowledge and impact positive behavior toward fulfilling iron nutrition.[26–28]

The WHO recommends eight ANC visits: one in the first trimester, two in the second trimester, and five in the third trimester.[29] The Indonesian Ministry of Health followed up through Regulation No. 21 of 2021, which states that ANC visits should be made at least six times (K6): two in the first trimester, one in the second trimester, and three in the third trimester, with at least two ANC visits at doctors.[8] The recommendation of having at least two visits to doctors increases the chance of pregnant women getting all the needed components of ANC, not only health counseling but also pregnancy risk screening and examinations. Previous studies in Lower and Middle-Income Countries (LMIIC) found that providers' delivery of ANC components differed by qualification (doctors, midwives, and nurses). Doctors delivered more complete examinations and pregnancy risk screening, while midwives had more time for health counseling. So, the combination of providers' examinations maximizes the chance of pregnant women getting all the needed ANC components.[30,31] This implies that the recommended six ANC visits were beneficial in preventing anemia in pregnancy. Health providers should encourage pregnant women to achieve the recommended six ANC visits. A limitation of this study is that it did not aim to assess the quality of antenatal care (ANC) provided by healthcare providers. Future research should consider evaluating both the quality and quantity of ANC services to provide a more comprehensive understanding.

This study also implies the need for pregnant women to consume IFA supplements routinely to prevent anemia. This finding supports a previous study that found that women who consumed iron supplements during pregnancy were less likely to have anemia.[32,33] Women who consumed IFA supplements irregularly also had an increased risk of anemia during pregnancy. As the WHO recommends, a daily dose of iron supplements is vital to prevent anemia, as the demand for iron is higher due to the increased blood supply during pregnancy.[13] This study suggests that women need to consume at least seven iron tablets per week to meet their iron needs, maintain their hemoglobin levels, and prevent anemia.

Another interesting finding of this study was women with a parity of 0 and 1 had a higher risk of pregnancy anemia than women with a parity of two or more. This result did not support the previous finding that stated multiparous women had a higher risk of anemia.[34,35] That occurred because the iron reserves used in the previous pregnancies and delivery were not fully replenished before the current pregnancy.[35] This study found different results, indicating that multiparous women had a lower risk of pregnancy anemia. This is likely due to the greater experience and knowledge observed in multiparous women compared to primiparous women.[25] The other reasonable reason for this was limited iron reserves before becoming pregnant.[36] As the previous study found, anemia was also prevalent in nulliparous women, even more in adolescents, including Indonesian adolescents.[37,38] This underscores the need to prevent anemia from adolescence to reduce the likelihood of anemia during pregnancy. Another potential confounder was diet. An additional analysis controlling for diet (daily iron intake) showed no change in results a parity of 0–1 still had a higher odds ratio than multipara, indicating that diet was not a confounder in this relationship. However, previous iron status remains a potential confounder, but it was not assessed in this study, representing a limitation. Future research should include prior iron status to better understand the link between parity and anemia during pregnancy.

Iron intakes do not significantly differ between anemic and non-anemic pregnant women, but this should be highlighted because anemia is part of a nutritional problem.[4,10,39] This study's findings align with prior research, indicating no significant correlation between the participants' iron consumption and the occurrence of anemia.[40] According to the FFQ, it is evident that the respondents still consume certain substances such as tannins, oxalates, and phytates, specifically tea, corn, tofu, sweet potato, and peanuts. These substances hinder the absorption of iron. The presence of substances such as tannins, oxalates, and phytates in legumes, vegetables, and cereal grains is called anti-nutritional factors. These compounds have an impact on the availability of proteins, as well as minor minerals like iron (Fe). Antinutrients hinder the efficient absorption and use of nutrients. Consequently, they impede the optimal bioavailability of nutrients in a food and diminish its nutritional value.[41] The respondent and other Javanese individuals had a customary practice of consuming tea following meals.[40] Thus, healthcare professionals must stress the importance of refraining from ingesting iron inhibitors, such as tea, after meals during nutrition counseling, particularly for pregnant women with anemia. However, this study did not quantify tea consumption in detail, limiting our ability to analyze its correlation with iron status and anemia risk. Future research should incorporate detailed assessments of tea intake to better understand its potential impact.

The study also found a significant association between the family welfare index and anemia. Belonging to a socioeconomically disadvantaged family increases the likelihood of experiencing anemia during pregnancy. Prior research indicates that the wealth index is crucial to determining anemia. Specifically, individuals in the lowest wealth quantile were more

likely to become anemic.[42] A lower wealth index indicates that respondents have limited incomes, which may restrict their access to iron-rich, nutritious foods or a well-balanced diet. As a result, this can lead to an inadequate diet, increasing the risk of anemia and poor health outcomes. In this study, other factors, such as gravidity and birth interval, were proven not to be significant determinants of anaemia.

Strength and Limitations

This study demonstrated the originality of establishing that adhering to the Indonesian ANC prescription of six visits effectively prevents anemia. However, the study was conducted in a specific facility, limiting its generalizability to all pregnant women in the community who did not attend antenatal care follow-up at the primary healthcare center. The use of SQ-FFQ to assess food intake over the past few months may result in recall bias and make it difficult to quantify the quantity of the diet accurately. It is advisable to conduct additional community-based studies on a wide scale. Further studies are also recommended to thoroughly investigate not only the quantity of ANC but also the quality of ANC delivery by healthcare providers, the respondents' previous iron status, and their tea consumption, which hinders iron absorption. This will help in gaining a deeper understanding of the factors contributing to anemia during pregnancy. Given the strengths and limitations of our research, we proposed that the findings can provide valuable insights for policymakers and physicians in preventing anemia during pregnancy. This study highlights the need to enhance the monitoring of pregnant women's adherence to ANC visits and IFA tablet consumption to prevent anemia during pregnancy. Special attention should be given to primiparous women, with healthcare providers dedicating more time to education and counseling.[43] Additionally, pregnant women from lower wealth index categories should receive instrumental support to ensure access to iron-rich, nutritious foods.

Conclusion

This study examined the factors contributing to anemia among pregnant women in the study area. The study found that ANC compliance, IFA consumption, parity and family wealth index were identified as independent predictors of pregnant anemia. Policy development should focus on improving compliance with ANC visits, IFA tablet consumption, and enhanced education for primiparous women. Health professionals should strengthen health education and counseling to emphasize the importance of attending the recommended six antenatal care visits and maintaining consistent iron and folic acid supplement intake.

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Availability of Data: The first author can provide the data presented in this study upon request.

Authors' Contributions: IA and SBAH conceptualized the research design. IA, EYB, DSI, and DAI write the research protocol and develop and pre-test the questionnaires. IA and F develop SQ-FFQ form. EYB, DSI, and DAI collected the data. IA analyzed the data and prepared the initial draft, framework, and interpretation. IA, F, KEW, AKU, and SBAH critically interpreted the study results and drafted the manuscript.

No use of generative AI tools: This article was prepared without the use of generative AI tools for content creation, analysis, or data generation. All findings and interpretations are based solely on the authors' independent work and expertise.

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