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The Relationship between Nutritional Status Based on Mid-Upper Arm Circumference (MUAC) and Hemoglobin Levels in Pregnant Women

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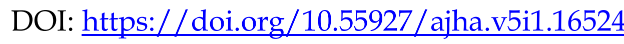
A B S T R A C T

This study aims to analyze the correlation between nutritional status, measured via Mid-Upper Arm Circumference (MUAC), and anemia incidence among pregnant women at Bogor Timur Health Center in 2025. This research contributes a basis for early detection and integrated interventions for healthcare providers to reduce maternal anemia. The study employed a quantitative analytical method with a cross-sectional design, involving 190 randomly selected samples. Data collection occurred from December 22, 2025, to February 14, 2026, using Chi-Square analysis. Results showed a significant relationship between MUAC ($p=0.019$) and gestational age ($p=0.000$) with anemia. Consequently, pregnant women with "at-risk" MUAC exhibit higher anemia proportions (38.7%), necessitating stricter nutritional monitoring.



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INTRODUCTION

Maternal anemia remains a critical public health challenge in Indonesia, significantly impacting both maternal and neonatal outcomes. In pregnant women, anemia increases the risk of postpartum hemorrhage, low birth weight, and stunted fetal growth (Tarmizi, S. N., 2024). While iron supplementation programs are widely implemented, the prevalence of anemia remains high, suggesting that nutritional status is a multifaceted issue (Adrianto, H., 2021). Mid-Upper Arm Circumference (MUAC) serves as a practical, non-invasive indicator of Chronic Energy Malnutrition (CEM) in pregnant women, yet its direct correlation with hemoglobin levels is often overlooked in routine clinical screenings (Akib, R. D., et al.,2025). This research addresses a specific gap by examining these variables within the urban-transitional context of the Bogor Timur Health Center in 2025 (Amalia, M. F., & Arianto, D. B., 2024). The study contributes to knowledge enrichment by providing empirical evidence on how maternal anthropometry directly mirrors hematological health in a niche local population (thereby offering a foundation for more integrated nutritional interventions, Bujani, N. N., Suarniti, N. W., & Cintari, L., 2023). This paper emphasizes the necessity of combining anthropometric measurements with clinical blood tests to achieve early detection. Consequently, this study aims to analyze the relationship between maternal MUAC and the incidence of anemia among pregnant women, specifically investigating how nutritional thresholds and gestational age contribute to the severity of the condition in this primary healthcare setting (Febrida, R., 2024).

LITERATURE REVIEW

Anemia in Pregnancy

Anemia in pregnancy is a condition where hemoglobin levels fall below 11 g/dL. According to the World Health Organization (WHO), this condition is primarily driven by increased physiological demands for iron during fetal development (Hapsari, L. T., et al 2025). If not managed, it leads to severe complications for both mother and child (Tchakounte Youngui, B. et al., 2022). Previous studies, such as research by Wibowo et al. (2021), suggest that iron deficiency is the most common cause, while research by Munah and Salsabila (2025) emphasizes that gestational age significantly influences hemoglobin fluctuations (Hidayat, M. F., & Hidayah, N, 2025).

Maternal Nutritional Status (MUAC)

Mid-Upper Arm Circumference (MUAC) is a standardized anthropometric measure used to assess Chronic Energy Malnutrition (CEM) in pregnant women. A MUAC of less than 23.5 cm indicates a high risk of malnutrition (Kemenkes, R. I., 2012). Previous quantitative research by Bujani et al. (2025) supports the hypothesis that poor nutritional status directly correlates with lower hemoglobin levels (Tendean, A. F., et al,2025). Conversely, some studies in different demographic settings suggest that anemia can occur regardless of MUAC size due to specific micronutrient deficiencies or genetic factors (Kemenkes, R. I,2018).

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H1: There is a significant relationship between Mid-Upper Arm Circumference (MUAC) and the incidence of anemia in pregnant women at Bogor Timur Health Center.

Gestational Age and Physiological Adaptation

Gestational age plays a vital role in blood volume expansion (hemodilution) (Ketiga, E., 2020). As pregnancy progresses, the plasma volume increases faster than red blood cell mass, often resulting in lower hemoglobin concentrations during the second and third trimesters (Statistik, B. P. 2024). Research by Langi et al. (2025) agrees that gestational age is a critical predictor of anemia status (Munah, F., & Salsabila, D. I. B., 2025).

H2: There is a significant relationship between gestational age and the incidence of anemia in pregnant women at Bogor Timur Health Center.

Conceptual Framework

The following framework illustrates the relationship between the independent variables (Nutritional Status/MUAC and Gestational Age) and the dependent variable (Anemia Incidence) (Wonda, N. N., & Nope, L. I., 2026).

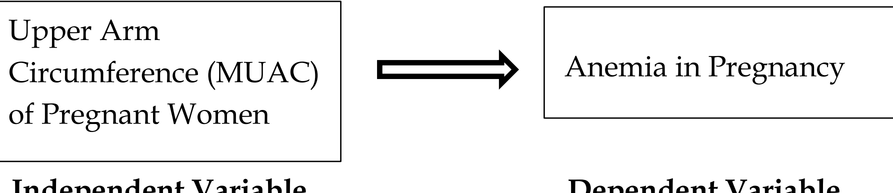

Figure 1. Conceptual Framework

METHODOLOGY

This study employs a quantitative analytical method with a cross-sectional design to investigate the correlation between maternal nutritional status and anemia (Sari, D. M., et al, 2022). The research was conducted at the Bogor Timur Health Center, with data collection occurring between December 22, 2025, and February 14, 2026 (Nadila, N. N., 2021). The study involved 190 samples selected through a random sampling technique to ensure empirical and representative results (Neng, S., 2025). The primary variables analyzed include maternal Mid-Upper Arm Circumference (MUAC) as an indicator of nutritional status and gestational age as a factor in physiological blood volume expansion (Sadikin, B. G., 2022). Anemia incidence serves as the dependent variable, defined by hemoglobin levels below 11 g/dL (Rickman, H. M., et al., 2025). Data analysis was performed using Chi-Square tests to determine the statistical significance of the relationships between the variables (Putri, D. P., et al., 2023). This systematic approach aims to provide a logical foundation for early detection and integrated nutritional interventions within a primary healthcare setting (Ratnawati, L., 2015).

RESULTS AND DISCUSSION

Table 1. Demographic Distribution of Pregnant Women at Bogor Timur Health Center in 2025

Subject Characteristics	Frequency (n)	Percentage (%)
Age (Years)		
< 20	12	6%
20 – 35	147	77%
> 35	31	16%
Parity		
0	66	35%
1	58	31%
2	48	25%
3	12	6%
4	5	3%
5	1	1%
Gestational Age		
Trimester I	89	47%
Trimester II	66	35%
Trimester III	35	18%
Hemoglobin (g/dL)		
< 11	43	23%
≥ 11	147	77%
Mid-Upper Arm Circumference (cm)		
< 23.5	31	16%
≥ 23.5	159	84%

Based on Table 1. the total sample analyzed consisted of 190 pregnant women. The largest age group was 20–35 years with 147 participants (77%), followed by those >35 years with 31 participants (16%), and those <20 years with 12 participants (6%). The majority of pregnant women at Bogor Timur Health Center in 2025 were nulliparous (never gave birth) at 66 participants (35%), followed by 58 participants (31%) who had given birth once, and 48 participants (25%) who had given birth twice. This was followed by three births (12 participants; 6%), four births (5 participants; 3%), and five births (1 participant; 1%). Regarding gestational age, 89 participants (47%) were in the first trimester (0–12 weeks), 66 participants (35%) in the second trimester (13–27 weeks), and 35 participants (18%) in the third trimester (>28 weeks). The number of pregnant women with hemoglobin levels <11 g/dL (anemic) was 43 (23%), while 147 (77%) had hemoglobin levels ≥11 g/dL (non-anemic). Mid-Upper Arm Circumference (MUAC) measurements showed 31 participants (16%) had a MUAC <23.5 cm, and 159 participants (84%) had a MUAC ≥23.5 cm.

Table 2. Relationship Between Maternal Age and Anemia

Maternal Age	Anemic				Total		*p value*
	Anemic		Non-Anemic				
	n	%	n	%	n	%	
At Risk	11	25.6%	32	74.4%	43	100%	0.599
Not At Risk	32	21.8%	115	78.2%	147	100%	

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According to Table 2. maternal age was categorized into "At Risk" (<20 and >35 years) and "Not At Risk" (20–35 years). Statistically, there was no significant relationship between maternal age and the incidence of anemia, with a p-value of 0.599 (>0.05). In the at-risk age group, 11 participants (25.6%) were anemic, while in the group not at risk, 32 participants (21.8%) were anemic.

Table 3. Relationship Between Parity and Anemia

Parity	Anemic				Total		*p value*
	Anemic		Non-Anemic				
	n	%	n	%	n	%	
At Risk	0	0%	1	100%	1	100%	0.588
Not At Risk	43	22.8%	146	77.2%%	189	100%	

Based on Table 3, parity >4 is considered at risk, while parity ≤4 is categorized as not at risk. The analysis showed no significant relationship between parity and anemia, with a p-value of 0.588 (>0.05). Most pregnant women fell into the "Not at Risk" category. Only one mother was in the at-risk parity group, and she was not anemic.

Table 4. Relationship Between Gestational Age and Anemia

Gestational Age	Anemic				Total		*p value*
	Anemic		Non-Anemic				
	n	%	n	%	n	%	
Trimester I	7	7.9%	82	91.2%	89	100%	0.000
Trimester II	22	33.3%	44	66.7%	66	100%	
Trimester III	14	40%	21	60%	35	100%	

Table 4. shows a significant relationship between gestational age and anemia (p=0.000). The prevalence of anemia increased as the pregnancy progressed. Anemia was found in 7.9% of participants in the first trimester, 33.3% in the second trimester, and reached the highest percentage in the third trimester at 40%.

Table 5. Relationship Between Mid-Upper Arm Circumference (MUAC) and Anemia

MUAC	Anemic				Total		*p value*
	Anemic		Non-Anemic				
	n	%	n	%	n	%	
At Risk	12	38.7%	19	61.3%	31	100%	0.019
Not At Risk	31	19.5%	128	80.5%%	159	100%	

Table 5. indicates a statistically significant relationship between MUAC measurements and anemia (p=0.019). A MUAC <23.5 cm indicates a risk of Chronic Energy Malnutrition (CEM). Pregnant women with a MUAC at risk showed a higher proportion of anemia (38.7%) compared to those with a MUAC not at risk (19.5%).

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Demographic Distribution of Pregnant Women

Based on Table 1, it is observed that the age distribution of pregnant women at Bogor Timur Health Center in 2025 was predominantly within the 20–35 years range, accounting for 147 individuals (77%), followed by those aged >35 years (31 individuals; 16%), and those aged <20 years (12 individuals; 6%). According to the Ministry of Health, Women of Reproductive Age (WRA) are defined as women aged 15–49 years. Furthermore, Ministry of Health Regulation No. 2 of 2025 states that the optimal age for pregnancy is between 20 and 35 years; women under 20 are advised to delay pregnancy, while those over 35 are encouraged to prevent further pregnancies. A woman's age is considered at risk if it is <20 or >35 years. In women under 20, the reproductive organs are still developing and are not yet mature enough for conception, posing risks of miscarriage, hemorrhage, malnutrition, and anemia. Conversely, in women over 35, reproductive organ function declines, tissues become less elastic, and hemoglobin production decreases, increasing the risk of anemia. Data from Table 4.1 indicate that the majority of pregnant women at Bogor Timur Health Center fall into the non-risk reproductive age category (20–35 years) regarding anemia. Regarding parity, most pregnant women at Bogor Timur Health Center in 2025 were nulliparous (never given birth), totaling 66 individuals (35%), followed by primiparous (one prior birth) at 58 individuals (31%). Multipara mothers (parity 2–4) accounted for 65 individuals (34%), comprising 48 with two births (25%), 12 with three (6%), and 5 with four (3%). Grandemultipara (parity >4) was represented by only one individual (1%). Higher parity tends to correlate with higher anemia rates due to the increased nutritional and red blood cell demands shared between the mother and fetus. Frequent pregnancies without adequate nutritional intake increase the risk. Furthermore, frequent births can lead to increased blood plasma volume, triggering hemodilution. Complications such as hemorrhage can also deplete hemoglobin and iron stores, leading to anemia.

Gestational age is calculated using the Naegele formula, measuring the time from the first day of the last menstrual period (LMP) to the date of examination. The first trimester spans 0–12 weeks, the second 13–27 weeks, and the third 28–40 weeks. Table 1 shows that the highest attendance for check-ups was in the first trimester (89 individuals; 47%), followed by the second (66 individuals; 35%), and the third (35 individuals; 18%). Antenatal care is a comprehensive series of quality activities for pregnant women from conception to delivery. Each pregnant woman should receive integrated antenatal care at least six times: twice in the first trimester, once in the second, and three times in the third. First-trimester visits are crucial for the early detection of risk factors or comorbidities. First-trimester mothers have a higher risk of anemia than those in the second trimester due to decreased appetite, nutritional deficiencies, and hemodilution starting at 8 weeks. However, the risk triples in the third trimester as iron transfer to the fetus peaks, depleting maternal iron reserves. Anemia is a condition where the number of erythrocytes is insufficient to meet body tissue oxygen requirements. It is generally diagnosed based on a decrease in hemoglobin (Hb) levels, erythrocyte count, and hematocrit (Hct) below normal limits. The WHO defines pregnancy anemia as Hb <11 g/dL or hematocrit <33%.

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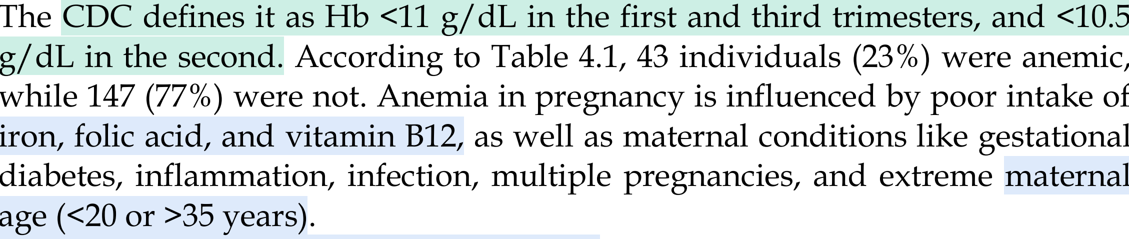

The CDC defines it as Hb <11 g/dL in the first and third trimesters, and <10.5 g/dL in the second. According to Table 4.1, 43 individuals (23%) were anemic, while 147 (77%) were not. Anemia in pregnancy is influenced by poor intake of iron, folic acid, and vitamin B12, as well as maternal conditions like gestational diabetes, inflammation, infection, multiple pregnancies, and extreme maternal age (<20 or >35 years).

Relationship Between Maternal Age and Anemia

The study found that maternal age has no significant relationship with the incidence of anemia. In the at-risk age group, 11 individuals (25.6%) were anemic, while 32 individuals (21.8%) in the non-risk group were anemic. This suggests that anemia can occur regardless of whether the mother is in the at-risk (<20 or >35 years) or non-risk (20–35 years) age range. This aligns with research by Akib et al. (2025), which found that age and anemia were not significantly related, as the outcome was heavily influenced by the consumption of iron supplements. At-risk mothers who regularly took supplements avoided anemia, while non-at-risk mothers who were non-compliant still experienced it. However, Wijaya et al. (2025) reported different results, suggesting that younger mothers (<20 years) face higher risks because their reproductive organs are not yet fully developed and they must share red blood cells with the growing fetus. Older mothers (>35 years) also face higher risks due to repeated pregnancies and other complications. Education and knowledge regarding anemia prevention also play a vital role in regional prevalence.

Relationship Between Parity and Anemia

Parity refers to the number of infants a woman has delivered, including live births and stillbirths. Table 3 shows no significant relationship between parity and anemia (p=0.588 > 0.05). Although grandemultipara (parity >4) is theoretically an at-risk category, the study only identified one such individual, who was not anemic. Meanwhile, 43 non-risk parity individuals (22.8%) were anemic. These findings correspond with studies by Yuvita et al. (2024) and Afni et al. (2023), which noted that other factors, such as maternal attitude, knowledge, prenatal monitoring, pregnancy intervals, and infections, are more influential.

The risk of anemia in nulliparous or primiparous women can be mitigated through routine obstetric monitoring, while the risk in high-parity women can be managed through family planning to regulate pregnancy intervals. A safe interval is at least 2 years post-delivery, allowing the mother's body to recover iron stores. Mid-Upper Arm Circumference (MUAC) is closely related to maternal nutritional status and is not significantly affected by gestational age, making it a reliable alternative to body weight assessment. MUAC helps evaluate energy reserves (fat mass) and protein stores (muscle mass). Good nutritional status is indicated by MUAC ≥23.5 cm. Table 1 shows that 31 individuals (16%) had a MUAC <23.5 cm, while 159 (84%) had a MUAC≥23.5 cm, indicating that most participants had good nutritional status.

Relationship Between Gestational Age and Anemia

Table 4 reveals a significant relationship between gestational age and anemia (p=0.000 < 0.05). The data show an increasing trend in anemia prevalence as pregnancy progresses: 7.9% in the first trimester, 33.3% in the second, and

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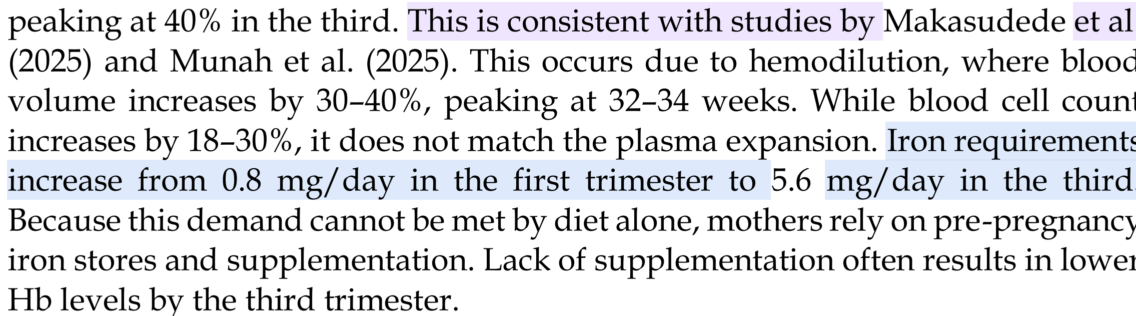

peaking at 40% in the third. This is consistent with studies by Makasudede et al. (2025) and Munah et al. (2025). This occurs due to hemodilution, where blood volume increases by 30–40%, peaking at 32–34 weeks. While blood cell count increases by 18–30%, it does not match the plasma expansion. Iron requirements increase from 0.8 mg/day in the first trimester to 5.6 mg/day in the third. Because this demand cannot be met by diet alone, mothers rely on pre-pregnancy iron stores and supplementation. Lack of supplementation often results in lower Hb levels by the third trimester.

Relationship Between Mid-Upper Arm Circumference (MUAC) and Anemia

Table 5. shows that mothers with an at-risk MUAC had a higher proportion of anemia (38.7%) compared to those with a non-risk MUAC (19.5%). Statistical analysis confirmed a significant relationship ($p=0.019 < 0.05$). This is supported by Putri et al. (2023), Bujani et al. (2021), and Wulandari et al. (2025). Chronic Energy Malnutrition (CEM), indicated by a MUAC <23.5 cm, often stems from inadequate nutritional intake. CEM can lead to hemorrhage, infections, fetal growth restriction, and low birth weight. The relationship between MUAC and anemia is often indirect; energy deficits cause the body to metabolize muscle protein for energy, reducing the protein available for heme formation in hemoglobin, thereby lowering Hb levels.

CONCLUSIONS AND RECOMMENDATIONS

This study concludes that there is a significant correlation between maternal Mid-Upper Arm Circumference (MUAC) and the incidence of anemia among pregnant women at the Bogor Timur Health Center ($p=0.019$). Additionally, gestational age shows a strong association with anemia ($p=0.000$), with the highest prevalence occurring in the third trimester (World Health Organization, 2024). Conversely, maternal age and parity do not show a statistically significant relationship with anemia in this specific population. These findings emphasize that maternal nutritional reserves, reflected by MUAC, are critical determinants of hematological health during pregnancy (Yuvita, L. et al., 2024). Based on these results, healthcare providers should prioritize the following implementations :

- Early Nutritional Screening: Intensive monitoring of MUAC should be conducted starting from the first antenatal care visit to identify women at risk of Chronic Energy Malnutrition (CEM).
- Trimester-Specific Interventions: Since anemia risk peaks in the third trimester, clinicians must ensure strict compliance with iron supplementation and nutritional counseling as the pregnancy progresses.
- Integrated Education: Counseling should focus on high-protein intake and iron-rich diets, specifically targeting mothers with a MUAC of <23.5 cm, regardless of their age or parity.

FURTHER STUDY

This study has several limitations that provide opportunities for further investigation. The cross-sectional design only captures a snapshot in time, preventing the establishment of long-term causal dynamics between nutritional

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shifts and hemoglobin fluctuations. Additionally, this research did not account for external confounding factors such as daily dietary diversity scores, the presence of infectious diseases, or the exact level of adherence to iron-folic acid (IFA) tablets. Future research should employ a longitudinal cohort approach to track nutritional status and hemoglobin levels from the first trimester through the postpartum period. Investigating the impact of specific micronutrient absorption enhancers and the role of socioeconomic interventions in improving MUAC scores would provide a more comprehensive strategy for eradicating maternal anemia.

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