Jurnal Kesehatan Ibu dan Anak ISSN: 2599-3224 (Online)
Vol.18, No.1, July 2024, pp. 34~43 ISSN: 2302-6014 (Print)
doi : 10.29238/kia.v18i1.2217

Impact of maternal nutritional status on anemia in the third trimester of pregnancy

Clarita Emilia Febiana[1], Nursyahid Siregar[2], Dewi Rinda Astuti[3], Jasmawati[4]
[1]Midwifery Department, Poltekkes Kemenkes Kalimantan Timur, Indonesia, claritaemiliafebiana@gmail.com
[2]Midwifery Department, Poltekkes Kemenkes Kalimantan Timur, Indonesia, siregarnursyahid@yahoo.co.id
[3]Midwifery Department, Poltekkes Kemenkes Kalimantan Timur, Indonesia, dewideri94@gmail.com
[4]Midwifery Department, Poltekkes Kemenkes Kalimantan Timur, Indonesia, jaswatijaswati@gmail.com

ARTICLE INFO

Article history:

Received: Jan 10th, 2024
Revised : July 20th 2025
Accepted: July 23rd 2025

Keyword:

Maternal anemia;
BMI;
MUAC;
Gestational weight gain;
Late pregnancy.

ABSTRACT

Anemia during pregnancy remains a prevalent public health concern, particularly in low-and middle-income countries. Nutritional status, including body mass index (BMI), mid-upper arm circumference (MUAC), and gestational weight gain (GWG), is believed to play a crucial role in the development of anemia, especially during the third trimester when physiological hemodilution peak. This study aims to analyze the relationship between maternal nutritional status (based on BMI, MUAC, and weight gain during pregnancy) and the incidence of anemia in the third trimester. This cross-sectional study was conducted among 53 pregnant women in their third trimester at the Bengkuring Public Health Centre, Samarinda, Indonesia in 2023. Data were collected using structured questionnaires and clinical assessments. Nutritional status was assessed via BMI, MUAC, and GWG, while anemia was determined using hemoglobin levels. Statistical analysis using Spearman correlation to determine the association between nutritional indicators and anemia incidence. A significant relationship was found between nutritional status and anemia. Underweight and overweight BMI were both associated with increased anemia prevalence ($p < 0.05$; $r = 0.275$), indicating that extreme BMI values pose a risk. Women with low MUAC (indicative of chronic energy deficiency) showed a higher proportion of anemia ($p = 0.046$; $r = -0.275$). Inadequate GWG was also significantly related to anemia ($p = 0.011$; $r = -0.345$). Most anemic cases were classified as mild, with overweight and undernourished women exhibiting higher susceptibility due to impaired iron metabolism and suboptimal nutrient reserves. The findings support the hypothesis that maternal nutritional status significantly influences anemia in late pregnancy. The results emphasize the need for early identification of at-risk women based on BMI, MUAC, and GWG. These parameters can serve as simple, cost-effective screening tools in antenatal care settings to prevent adverse maternal and fetal outcomes. This study concludes that both undernutrition and overnutrition are significantly associated with anemia during late pregnancy. Monitoring maternal nutritional indicators such as BMI, MUAC, and GWG is essential in antenatal practice to reduce anemia-related complications.

Corresponding Author:

Clarita Emilia Febiana
Midwifery Department, Poltekkes Kemenkes Kalimantan Timur
Wolter Monginsidi Street No. 38, Sidodadi, Samarinda Ulu, Samarinda, East Kalimantan, Indonesia.
Phone: (0541)738153 Fax; (0541)768523
Email: claritaemiliafebiana@gmail.com

Jurnal Kesehatan Ibu dan Anak Vol.18, No.1, July 2024, pp. 34~43
ISSN: 2599-3224 (Online), ISSN: 2302-6014 (Print)

INTRODUCTION

The global prevalence of anemia among pregnant women stands at approximately 41.8%, with significant regional variations from 31% in South America to 64% in Southern Asia.(1) In Indonesia, the rate reaches 48.9%, and in East Kalimantan specifically, it is 44.5%.(2) Local data from the Samarinda City Health Service reports 1,778 pregnant women diagnosed with anemia in 2021.(3)

Anemia in pregnancy poses serious risks not only to the mother but also to fetal outcomes. A recent systematic review and meta-analysis of cohort studies found that maternal anemia significantly increases the risk of preterm birth (RR 1.51), low birth weight (LBW) (RR 1.40), postpartum hemorrhage, cesarean section, gestational hypertension, and neonatal asphyxia.(4) Another comprehensive review in low- and middle-income countries reported elevated risks of LBW (RR 1.31), preterm birth (RR 1.63), perinatal mortality, and neonatal mortality among anemic pregnant women.(5) These outcomes are particularly pronounced in settings with high anemia prevalence such as in East Kalimantan.

Maternal nutritional status both before and during pregnancy is well recognized as crucial for fetal development and maternal hematological health. Standard indicators such as Body Mass Index (BMI), mid-upper arm circumference (MUAC), and gestational weight gain are commonly used to assess nutritional adequacy.(6) However, questions remain regarding which indicator most strongly correlates with anemia risk, especially in the third trimester, a period when physiological hemodilution and iron demand peak.

Current literature often focuses on single nutritional indicators, without comparing the predictive value of BMI, MUAC, and weight gain within the same cohort. For instance, Acharya et al. (2024) reported that underweight status (BMI < 18.5) was associated with anemia risk (COR, 1.17; CI: 1.02–1.34)(7), whereas MUAC did not independently predict anemia in their multivariate model suggesting potential measurement inconsistencies.(8) Similarly, a meta by Zhang et al. (2022) concluded that low MUAC (< 23 cm) and inadequate gestational weight gain were independently associated with anemia, but did not evaluate combined indicators within a single population.(9) Moreover, demographic factors such as maternal age, parity, education level, rural residency, and household income have been identified as significant predictors of anemia in broader analyses, yet few studies stratify the relationships between these factors and specific nutritional measurements and how they jointly influence anemia outcomes in late pregnancy.(10)

In Indonesia and similar low-resource settings, women may experience a double burden of malnutrition both undernutrition and overnutrition yet evidence examining the U-shaped risk pattern (where both extremes of BMI correlate with anemia) in the third trimester is limited.(11)(12–15) This creates an important knowledge gap about the comparative strength of BMI, MUAC, and weight gain as anemia predictors, how demographic subgroups might moderate these associations, and how these dynamics specifically operate during the high-risk physiological trimester of pregnancy.

Therefore, the present study addresses this gap by simultaneously evaluating BMI, MUAC, and gestational weight gain and testing whether they differentially predict anemia among third-trimester pregnant women while considering sociodemographic variables commonly underexplored in prior research. By integrating the three nutritional status indicators used in previous research, this study is expected to provide a more comprehensive and accurate picture of the effect of nutritional status on anemia. This study aims to analyze the relationship between maternal nutritional status based on BMI, MUAC, and weight gain during pregnancy and the incidence of anemia in the third trimester.

METHOD

This study employed a quantitative, analytical cross-sectional design conducted over 14 days, from November 17 to December 2, 2023, in Samarinda, East Kalimantan, Indonesia. Data were collected at a single time point for each participant. The study population

Jurnal Kesehatan Ibu dan Anak Vol.18, No.1, July 2024, pp. 34~43
ISSN: 2599-3224 (Online), ISSN: 2302-6014 (Print)

comprised third-trimester pregnant women diagnosed with anemia. A total of 53 participants were selected using purposive sampling. Inclusion criteria were: (1) third-trimester pregnancy, (2) hemoglobin level <11 g/dL based on the Maternal and Child Health (MCH) book, (3) consistent consumption of iron (Fe) tablets as recorded in antenatal records, (4) availability of a complete MCH book, and (5) willingness to participate as indicated by informed consent. Exclusion criteria included a history of chronic diseases (e.g., diabetes, hypertension), multiple pregnancies, or recent blood transfusion. Primary data collection involved anthropometric measurements and direct interviews, while secondary data were obtained from the MCH book. Nutritional status was assessed using three indicators: Body Mass Index (BMI) was calculated as weight (kg) divided by height squared (m^2), using standardized digital scales and stadiometers. Mid-upper arm circumference (MUAC) was measured on the left arm using a non-stretchable measuring tape; values ≤23.5 cm indicated undernutrition. Gestational weight gain (GWG) was determined by subtracting pre-pregnancy weight from current pregnancy weight as recorded in the MCH book. All measurements were performed by trained midwives following standard procedures. Calibration of equipment and consistency in measurement techniques were ensured through pre-study training. Data were analyzed using SPSS version 26. The Spearman rank correlation test was applied to determine the association between nutritional status indicators (BMI, MUAC, and GWG) and the incidence of anemia, due to the non-parametric distribution of the variables. A p-value of <0.05 was considered statistically significant.

RESULTS

The study involved 53 third-trimester pregnant women, predominantly in the mature age group (98.1%) and multiparous (67.9%). Most respondents had a senior high school education (58.5%) and were housewives (69.8%). These characteristics reflect a population with relatively stable sociodemographic backgrounds that may influence maternal nutritional status and anemia risk (Table 1).

Table 1. Frequency Distribution of the Respondent Characteristics

Respondent Characteristics	Frequency (f)	Percentage (%)
Age		
Adolescent (10-18) Years	1	1.88
Mature (19-59) Years	52	98.11
Educational Level		
Junior High School	8	15.09
Senior High School	31	58.49
Vocational school	7	13.20
College	7	13.20
Work		
Housewife	37	69.81
Honorary	2	3.77
Private	10	18.86
Civil servants	4	7.54
Parity		
Primipara	17	32.07
Multiparous	36	67.92
Total	53	100

Table 2 presents the distribution of hemoglobin levels among third-trimester pregnant women. The majority of respondents were classified as having mild anemia (67.93%), followed by moderate anemia (32.07%). No cases of severe anemia or normal hemoglobin values were observed, indicating that anemia was prevalent in the entire study population.

Jurnal Kesehatan Ibu dan Anak Vol.18, No.1, July 2024, pp. 34~43
ISSN: 2599-3224 (Online), ISSN: 2302-6014 (Print)

Table 2. Distribution of Hemoglobin Levels among Respondents

Hemoglobin Level (g/dL)	Classification (WHO)	Frequency (n)	Percentage (%)
10.0–10.9	Mild Anemia	36	67.93
7.0–9.9	Moderate Anemia	11	32.07
< 7.0	Severe Anemia	0	0.0
≥ 11.0	Normal	0	0.0
Total	—	**53**	**100**

Table 3 shows the nutritional status of respondents. Nearly half of the pregnant women were overweight or obese (47.2%), while 9.4% were underweight and 43.4% had a normal BMI. Regarding mid-upper arm circumference (MUAC), 22.6% were at risk of chronic energy deficiency (CED), and 77.4% were within the normal range. In terms of gestational weight gain, 64.2% achieved weight gain compatible with Institute of Medicine (IOM) recommendations, whereas 35.8% did not.

Table 3. Nutritional Status of Respondents

Variable	Category	Frequency (n)	Percentage (%)
Body Mass Index (BMI)	Underweight	5	9.4
	Normal/Desirable	23	43.4
	Overweight/Obese	25	47.2
Mid-Upper Arm Circumference	< 23.5 cm (At risk/CED)	12	22.6
	≥ 23.5 cm (Normal)	41	77.4
Gestational Weight Gain	Compatible (IOM criteria)	34	64.2
	Non-compatible	19	35.8

The correlations between nutritional indicators and anemia status are summarized in Table 4. A weak positive correlation was observed between BMI and anemia (r = 0.275, p = 0.046), suggesting that higher BMI was associated with increased likelihood of anemia. MUAC demonstrated a weak negative correlation with anemia (r = –0.275, p = 0.046), indicating that lower MUAC values were related to greater anemia risk. Gestational weight gain also showed a weak negative correlation with anemia (r = –0.345, p = 0.011), implying that inadequate weight gain increased the likelihood of anemia. Although the strength of correlations was weak, the findings were statistically significant, suggesting a measurable but modest relationship between nutritional status and anemia in late pregnancy.

Table 4. Correlation between Nutritional Indicators and Anemia in Third-Trimester Pregnant Women

Nutritional Indicator	Category	Anemia Classification				Correlation Coefficient (r)	p-value	Interpretation
		Mild		Moderate				
		n	%	n	%			
Body Mass Index (BMI)	Underweight	3	5.66	2	3.78	0.275	0.046	Weak positive correlation
	Normal/ Desirable	19	35.85	4	7.55			
	Overweight/ Obese	14	26.42	11	20.75			
Mid-Upper Arm Circumference (MUAC)	< 23.5 cm (At risk/ CED)	11	20.75	1	1.89	–0.275	0.046	Weak negative correlation
	≥ 23.5 cm (Normal)	25	47.17	16	30.19			
Gestational Weight Gain (GWG)	Compatible (IOM criteria)	19	35.85	15	28.30	–0.345	0.011	Weak negative correlation
	Non-compatible	17	32.07	2	3.78			

Jurnal Kesehatan Ibu dan Anak Vol.18, No.1, July 2024, pp. 34~43
ISSN: 2599-3224 (Online), ISSN: 2302-6014 (Print)

DISCUSSION

The sociodemographic profile of the respondents revealed that the majority were aged above 20 years, had completed at least secondary education (58.49%), and were predominantly housewives (69.81%). Most were multiparous (67.92%), indicating a reproductive history that may influence nutritional reserves and anemia risk. While age, education, and occupation were not directly analyzed as independent predictors, they form an important contextual background. Although in our sample most women were adults of reproductive age, age was not directly linked to anemia incidence. In contrast, a systematic review in Egypt reported that maternal age ≥30 years significantly increased anemia risk (OR ≈ 1.95), likely due to cumulative nutritional depletion and comorbidities.(16) Another analysis in Ethiopia found maternal age ≥30 years was also a predictor (AOR ≈ 3.45) of anemia.(17) These discrepancies suggest that age-related anemia risk may depend on setting-specific factors such as health service uptake or parity distribution. Our findings show over half of respondents had a high school education level, but no clear link to anemia. By contrast, meta-analyses in Ethiopia and Egypt identified illiteracy or low education as consistent risk factors for maternal anemia (e.g., AOR ≈ 1.93 for illiteracy).(16,18) Education influence health literacy, antenatal attendance, diet awareness, and compliance with iron supplementation all mediators between education and anemia risk.(19,20) Most participants were housewives. Few studies explicitly compare occupation categories with anemia risk, but in the Tanzanian study, anemia was more prevalent among multiparous women and those with lower education or unemployment.(21) Occupational inactivity co-associate with socioeconomic disadvantage, contributing to anemia indirectly through limited access to nutritious food or healthcare. Multiparity is a known risk factor for anemia, as repeated pregnancies can deplete iron and micronutrient stores, especially if interpregnancy intervals are short or nutritional replenishment is inadequate. Our study found a predominance of multiparous women (67.9%). Prior meta-analytic reviews document that multiparity significantly increases anemia risk: women with ≥3 births had nearly 3–4 times higher odds of developing anemia during pregnancy.(9) Retrospective data also show multiparous women have lower hemoglobin and ferritin levels compared to nulliparous women (OR ≈ 2.13). (22) These findings reinforce that repeated pregnancies especially with short interpregnancy intervals erode maternal iron stores.

The present study demonstrated weak but statistically significant correlations between maternal nutritional indicators and anemia incidence in third-trimester pregnant women. A positive correlation was observed between body mass index (BMI) and anemia ($r = 0.275$, $p = 0.046$). This interpretation suggests that not only low nutritional status, but also high nutritional status is associated with anemia, further strengthening the research question of how these two nutritional extremes trigger anemia risk in the third trimester. Conversely, mid-upper arm circumference (MUAC) and gestational weight gain (GWG) both showed weak negative correlations with anemia ($r = –0.275$, $p = 0.046$ and $r = –0.345$, $p = 0.011$, respectively), suggesting that better nutritional reserves and appropriate weight gain were related to lower anemia prevalence. These findings highlight that while nutritional factors play a role, the relationship is multifactorial and modest in strength, reflecting the influence of other biological, dietary, and socioeconomic determinants.

Maternal overweight is associated with a low inflammatory state (meta-inflammation), which increases pro-inflammatory cytokines (IL-6, TNF-α), triggers an increase in hepcidin, and inhibits intestinal iron absorption consistent with anemia of inflammation (anemia of chronic disease).(22) A 2021 systematic review found that obesity before pregnancy significantly increases the risk of iron deficiency and anemia during pregnancy (IDA), particularly in overweight and obese women, and recommended closer monitoring of iron status and weight gain in this population.(23) A cohort study in Mexico showed that mothers with obesity and excessive weight gain had lower hemoglobin levels in the third trimester than obese mothers with appropriate weight gain (12.1 vs. 13.3 g/dL;

Jurnal Kesehatan Ibu dan Anak Vol.18, No.1, July 2024, pp. 34~43
ISSN: 2599-3224 (Online), ISSN: 2302-6014 (Print)

p=0.04). This finding supports the observation in this study that being overweight increases the likelihood of moderate anemia.(24) Mothers with a low BMI had mild anemia confirms the meta-analysis findings of Zhang et al. (2022) that underweight and low MUAC (<23 cm) are independent risk factors for anemia during pregnancy (AOR ≥1.23).(25) This suggests that classical micronutrient and energy malnutrition remain significant contributors to anemia. The meta-analysis also reported that MUAC <23 cm was associated with up to a threefold increased risk of anemia (OR ≈2.75). This study adds to the literature by demonstrating a U-shaped pattern of risk across nutritional status both underweight and overweight are associated with increased anemia, but the direction and type of anemia differed slightly (moderate anemia was higher in the overweight group). Furthermore, correlation analysis showed a distinct effect a stronger one for weight gain (r=–0.345) than for BMI and MUAC (r≈±0.275). This study strengthens the argument that the distribution of maternal nutritional status is not simply linear. In obstetric practice, this underscores the need for multi-indicator nutritional status assessment and intervention strategies that differentiate approaches for overweight, underweight, and normal BMI.

Table 4 reveals a notable distribution of anemia severity among pregnant women with varying mid-upper arm circumference (MUAC) measurements. The findings provide strong evidence supporting the research hypothesis that nutritional status, particularly CED measured by MUAC, is significantly associated with anemia in the third trimester of pregnancy. A lower MUAC reflects diminished protein and energy reserves, often accompanied by deficiencies in essential micronutrients such as iron, folate, and vitamin B12 as critical components in hematopoiesis. Consequently, CED lead to compromised iron bioavailability and reduced erythropoiesis, predisposing women to anemia even in the absence of acute nutritional deprivation. The results of this study align with a growing body of international literature. A study conducted in Oromia, Ethiopia, reported that pregnant women with MUAC <23 cm had five times higher odds of developing anemia compared to their counterparts with adequate MUAC values (p < 0.001).(26) Similarly, a recent meta-analysis in Indonesia confirmed that CED was one of the strongest predictors of anemia during pregnancy, with a pooled odds ratio of 3.81 (95% CI: 2.36–6.14), reinforcing the clinical importance of MUAC as a practical screening tool.(27) Additionally, research conducted by Hasan (2024) emphasized that MUAC was a stronger predictor of anemia than body mass index, especially in resource-limited settings.(28) This study contributes to the literature by offering context-specific insights into how MUAC correlates with anemia severity among third-trimester pregnant women. The moderate but significant negative correlation observed in this study suggests that MUAC can serve not only as an indicator of nutritional status but also as a proxy measure for predicting anemia risk especially where laboratory diagnostics are not readily available. Given the physiological demands of the third trimester, including increased plasma volume, and heightened fetal iron requirements, the presence of even mild anemia in CED mothers is clinically relevant. These findings underscore the need for routine MUAC screening during antenatal care and for targeted nutritional interventions that address both macro- and micronutrient deficiencies to mitigate the risk of adverse maternal and neonatal outcomes.

Table 4 also demonstrates a significant relationship between gestational weight gain and the incidence of anemia in pregnant women. The findings provide empirical support to the central hypothesis that suboptimal nutritional status, as reflected by insufficient gestational weight gain, contributes to the incidence and severity of anemia in pregnancy. Physiologically, inadequate weight gain is often indicative of poor macronutrient and micronutrient intake, particularly iron, folate, and vitamin B12, which are essential for erythropoiesis. This condition is further exacerbated by the natural hemodilution that occurs in the third trimester, which amplifies the manifestation of anemia in women with marginal iron stores. Our results are consistent with findings from recent international studies. For instance, a cohort study conducted by Nadhifa et al. (2023) in Sangkrah, Surakarta,

Jurnal Kesehatan Ibu dan Anak Vol.18, No.1, July 2024, pp. 34~43
ISSN: 2599-3224 (Online), ISSN: 2302-6014 (Print)

Indonesia found that inadequate gestational weight gain was significantly associated with a higher risk of anemia, especially in the third trimester ($p < 0.05$).(15) Similarly, Tan et al. (2018) in China reported that insufficient weight gain was a predictor of anemia with an adjusted odds ratio of 1.86 (95% CI: 1.26–2.76).(29) Notably, this study adds to the body of knowledge by analyzing how weight gain inconsistencies correspond to both mild and moderate forms of anemia, rather than treating anemia as a binary outcome. It offers nuanced insights into the clinical relevance of monitoring weight gain not only for fetal outcomes but also for maternal hematological health. In resource-limited settings, tracking gestational weight gain can serve as a practical proxy for assessing anemia risk when laboratory hemoglobin testing is not feasible. Taken together, the findings underscore the importance of early nutritional counseling and regular monitoring of weight gain during antenatal visits as part of integrated anemia prevention strategies. Addressing underlying dietary inadequacies through targeted supplementation and education can help prevent the onset of anemia and improve overall maternal outcomes.

This study presents several limitations that should be acknowledged. First, the cross-sectional design restricts the ability to infer causality between nutritional status and anemia. While associations were identified, temporal relationships and potential bidirectional influences cannot be firmly established. Second, the sample size, although adequate for statistical analysis, was drawn from a single geographic location, which may limit the generalizability of findings to broader populations, especially those with differing sociodemographic and nutritional profiles. Third, certain confounding variables, such as dietary intake quality, infection status (e.g., malaria or helminthiasis), and adherence to iron supplementation, were not comprehensively assessed, which may influence the observed relationships. Additionally, anthropometric measurements such as mid-upper arm circumference (MUAC) and body mass index (BMI) can be affected by gestational age and fluid retention, potentially biasing the assessment of nutritional status. Given these limitations, future research should consider employing longitudinal or cohort study designs to better understand the causal relationship between maternal nutritional status and anemia across the trimesters of pregnancy. It is also recommended that future studies incorporate dietary assessments, biomarkers of inflammation (e.g., CRP, hepcidin), and micronutrient levels (e.g., serum ferritin, folate, vitamin B12) to capture a more comprehensive picture of maternal nutritional status and its impact on hematological outcomes. Expanding the study to multiple regions and diverse populations would enhance the external validity and provide more robust evidence for policy formulation. Moreover, intervention studies evaluating the effectiveness of integrated nutrition and anemia prevention programs could provide practical insights for improving maternal health outcomes.

CONCLUSION

This study highlights a significant association between maternal nutritional status specifically underweight and overweight BMI, mid-upper arm circumference (MUAC), gestational weight gain and the incidence of anemia in late pregnancy. Pregnant women with underweight and overweight BMI were more likely to experience anemia, indicating a U-shaped risk pattern where both extremes of nutritional status increase vulnerability. Low MUAC, indicative of CED, was also found to be strongly associated with anemia, underscoring the importance of adequate protein and micronutrient intake during pregnancy. Furthermore, inappropriate gestational weight gain, whether excessive or insufficient, emerged as a predictor of anemia, likely reflecting suboptimal nutritional patterns and physiological stress during pregnancy.

These findings reinforce the clinical importance of routine nutritional assessment including BMI, MUAC, and monitoring of gestational weight gain as part of antenatal care protocols. Early detection and nutritional counseling tailored to the mother's baseline nutritional status may reduce anemia risk and improve maternal-fetal outcomes. The study adds to the growing body of evidence emphasizing the multifactorial nature of maternal anemia and its strong linkage with modifiable nutritional indicators. Future research should adopt longitudinal designs to explore causal pathways and incorporate comprehensive nutritional and inflammatory biomarker profiling. Expanding research across diverse populations and integrating behavioral, dietary, and supplementation factors will further elucidate the complex interplay between nutrition and maternal anemia, facilitating more effective prevention strategies.

AUTHOR CREDIT STATEMENT

CEF: Conceptualization, Methodology, Data Collection, Formal Analysis, Writing – Original Draft, Writing – Review & Editing, Visualization; **NS, DRA, JJ**: Methodology, Supervision, Validation.

FUNDING

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

DECLARATION OF COMPETING INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

REFERENCES

1. Anaemia in women and children [Internet]. [cited 2023 Oct 3]. Available from: https://www.who.int/data/gho/data/themes/topics/anaemia_in_women_and_children

2. Badan Penelitian dan Pengembangan Kesehatan. Laporan Nasional RISKESDAS 2018. Jakarta: Lembaga Penerbit Badan Penelitian dan Pengembangan Kesehatan; 2019.

3. Dinas Kesehatan Kota Samarinda. Profil Kesehatan Kota Samarinda Tahun 2021 [Internet]. Kota Samarinda: Dinas Kesehatan Kota Samarinda; 2021 [cited 2025 Sept 24]. Available from: https://www.scribd.com/document/723069329/Profil-Kesehatan-Kota-Samarinda-Tahun-2021

4. Wang R, Xu S, Hao X, Jin X, Pan D, Xia H, et al. Anemia during pregnancy and adverse pregnancy outcomes: a systematic review and meta-analysis of cohort studies. Front Glob Womens Health. 2025;6:1502585.

5. Rahman MM, Abe SK, Rahman MS, Kanda M, Narita S, Bilano V, et al. Maternal anemia and risk of adverse birth and health outcomes in low- and middle-income countries: systematic review and meta-analysis12. Am J Clin Nutr. 2016 Feb 1;103(2):495–504.

6. Ambreen S, Yazdani N, Alvi AS, Qazi MF, Hoodbhoy Z. Association of maternal nutritional status and small for gestational age neonates in peri-urban communities of Karachi, Pakistan: findings from the PRISMA study. BMC Pregnancy Childbirth. 2024 Mar 22;24:214.

7. Acharya SR, Timilsina D, Acharya S. Association between blood hemoglobin levels, anemia, and body mass index in children and women of Myanmar: findings from a nationally representative health study. Sci Rep. 2024 Dec 30;14:32020.

Jurnal Kesehatan Ibu dan Anak Vol.18, No.1, July 2024, pp. 34~43
ISSN: 2599-3224 (Online), ISSN: 2302-6014 (Print)

8. Nadhiroh SR, Hasugian AR, Nurhayati, Muthiah AD, Putri ANPA. Model development for anemia prediction in pregnancy. Clin Epidemiol Glob Health. 2024 July;28:101654.

9. Zhang J, Li Q, Song Y, Fang L, Huang L, Sun Y. Nutritional factors for anemia in pregnancy: A systematic review with meta-analysis. Front Public Health. 2022;10:1041136.

10. Shofiana FI, Widari D, Sumarmi S. Pengaruh Usia, Pendidikan, dan Pengetahuan Terhadap Konsumsi Tablet Tambah Darah pada Ibu Hamil di Puskesmas Maron, Kabupaten Probolinggo. Amerta Nutr. 2018 Dec 1;2(4):356–63.

11. Septiani S, Irfiyanti I, Hai T, Wiradnyani L, Kekalih A, Sahanggamu P. Food Insecurity Associated with Double-Burden of Malnutrition among Women in Reproductive Age in Ciampea Sub-district, Bogor, West Java. Indones J Public Health Nutr IJPHN [Internet]. 2021 Apr 30;1(2). Available from: https://scholarhub.ui.ac.id/ijphn/vol1/iss2/3

12. Kamaruddin M, Hasrawati, Usmia S, Jusni, Misnawaty, Handayani I. Korelasi Antara Status Gizi Dan Kadar Hemoglobin Pada Kejadian Anemia Ibu Hamil Trimester III. Med Alkhairaat J Penelit Kedokt Dan Kesehat. 2019 Dec 31;1(3):82–8.

13. Adriati F, Chloranyta S. Status Gizi Ibu Hamil Berdasarkan Pengukuran Lingkar Lengan Atas (LILA). J Kesehat Panca Bhakti Lampung. 2022 Oct 31;10(2):127–34.

14. Mooduto N, Harismayanti H, Retni A. Kenaikan Berat Badan Ibu Selama Kehamilan Dengan Berat Badan Lahir Bayi Di RSIA Sitti Khadijah Kota Gorontalo. J Rumpun Ilmu Kesehat. 2023 Mar 6;3(1):165–75.

15. Nadhifa B, Maulina R, Sari AAA, Putri NR, Nurhidayati S. The Relationship between Weight Gain and The Anemia in The Third Trimester Pregnant Women in Sangkrah Surakarta Health Center Area. J KEBIDANAN. 2023 Apr 27;13(1):46–52.

16. Azzam A, Khaled H, Alrefaey AK, Basil A, Ibrahim S, Elsayed MS, et al. Anemia in pregnancy: a systematic review and meta-analysis of prevalence, determinants, and health impacts in Egypt. BMC Pregnancy Childbirth. 2025 Jan 14;25(1):29.

17. Balcha WF, Eteffa T, Tesfu AA, Alemayehu BA, Chekole FA, Ayenew AA, et al. Factors associated with anemia among pregnant women attended antenatal care: a health facility-based cross-sectional study. Ann Med Surg. 2023 Apr 11;85(5):1712–21.

18. Geta TG, Gebremedhin S, Omigbodun AO. Prevalence and predictors of anemia among pregnant women in Ethiopia: Systematic review and meta-analysis. PLoS ONE. 2022 July 27;17(7):e0267005.

19. Malaka NMA, Irwan I, Ahmad ZF. Factors Associated with the Incidence of Anemia in Pregrant Women in Tapa Public Health Center Working Area. J Health Sci Gorontalo J Health Sci Community. 2023 Jan 27;7(1):143–52.

20. Irawati D, Syalfina AD, Priyanti S, Ssekalembe G. Determinants of Anemia in The Third Trimester of Pregnancy in Mojokerto. J Berk Epidemiol. 2021 Sept 24;9(3):211–20.

21. Kassie GA, Hailegebireal AH, Gebrekidan AY, Woldegeorgis BZ, Adella GA, Haile KE, et al. Anemia status and its determinants among reproductive-age women in Tanzania:

Jurnal Kesehatan Ibu dan Anak Vol.18, No.1, July 2024, pp. 34~43
ISSN: 2599-3224 (Online), ISSN: 2302-6014 (Print)

A multi-level analysis of Tanzanian demographic and health survey data. PLOS ONE. 2024 Nov 18;19(11):e0311105.

22. Wawer AA, Hodyl NA, Fairweather-Tait S, Froessler B. Are Pregnant Women Who Are Living with Overweight or Obesity at Greater Risk of Developing Iron Deficiency/Anaemia? Nutrients. 2021 May 7;13(5):1572.

23. Yang Y, Cai Z, Zhang J. The effect of prepregnancy body mass index on maternal micronutrient status: a meta-analysis. Sci Rep. 2021 Sept 13;11:18100.

24. Cantoral A, Ramírez-Silva I, Lamadrid-Figueroa H, Christensen DL, Bygbjerg IC, Groth-Grunnet L, et al. Pre-pregnancy body mass index and gestational weight-gain predict maternal hemoglobin levels and are jointly associated with neonatal outcomes in a Mexican birth cohort. Nutr Hosp. 2022 Aug 25;39(4):852–62.

25. Zhang J, Li Q, Song Y, Fang L, Huang L, Sun Y. Nutritional factors for anemia in pregnancy: A systematic review with meta-analysis. Front Public Health. 2022;10:1041136.

26. Zillmer K, Pokharel A, Spielman K, Kershaw M, Ayele K, Kidane Y, et al. Predictors of anemia in pregnant women residing in rural areas of the Oromiya region of Ethiopia. BMC Nutr. 2017 July 25;3:65.

27. Lipoeto NI, Masrul null, Nindrea RD. Nutritional contributors to maternal anemia in Indonesia: Chronic energy deficiency and micronutrients. Asia Pac J Clin Nutr. 2020;29(Suppl 1):S9–17.

28. Hasan RT. Mid-upper arm circumference as a tool to assess the nutritional status of pregnant women and associated factors. J Educ Health Promot. 2025 July;14(1):284.

29. Tan J, Qi YN, He GL, Yang HM, Zhang GT, Zou K, et al. Association between Maternal Weight Indicators and Iron Deficiency Anemia during Pregnancy: A Cohort Study. Chin Med J (Engl). 2018 Nov 5;131(21):2566–74.