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Association Between Third-Trimester Maternal Anemia and Low Birth Weight: A Prospective Cohort Study at Sikumana Primary Health Center

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ABSTRACT

Background: Maternal anemia remains one of the most common complications during pregnancy and continues to pose a significant public health challenge, particularly in low- and middle-income countries. Reduced hemoglobin concentration during pregnancy may impair oxygen and nutrient transport from mother to fetus, potentially resulting in suboptimal fetal growth and adverse perinatal outcomes, including low birth weight.

Objective: To evaluate the association between anemia in third-trimester pregnant women and the incidence of low birth weight among newborns at Sikumana Primary Health Center.

Methods: This study employed an observational analytic design with a prospective cohort approach. A total of 50 third-trimester pregnant women and their newborns were enrolled. Maternal hemoglobin levels were measured using venous blood samples analyzed in the laboratory, while neonatal birth weight data were obtained from maternal and child health records or birth certificates. Data normality was assessed using the Kolmogorov–Smirnov test, and the relationship between maternal anemia and birth weight was analyzed using Pearson correlation.

Results: The prevalence of anemia among third-trimester pregnant women was 36%, while the incidence of low birth weight was 40%. The most frequently observed erythrocyte morphologies were microcytic hypochromic and normocytic normochromic patterns. Statistical analysis demonstrated a significant association between maternal anemia and low birth weight ($p = 0.032$), with a moderate correlation strength ($r = 0.304$).

Conclusion: Anemia in the third trimester of pregnancy was significantly associated with low birth weight among infants delivered at Sikumana Primary Health Center. Strengthening early detection and management of maternal anemia may contribute to improved neonatal outcomes.

KEYWORDS: anemia, pregnancy, low birth weight, newborn, primary health care

INTRODUCTION

Anemia in pregnancy is commonly defined as a hemoglobin concentration below 11 g/dL in the first and third trimesters and below 10.5 g/dL in the second trimester, reflecting physiological plasma volume expansion during gestation.[1,2] Beyond gestational physiology, maternal anemia is influenced by multiple determinants, including maternal age, parity, educational attainment, socioeconomic status, and adherence to iron supplementation.[3]

At the population level, anemia during pregnancy remains highly prevalent. The World Health Organization reported that approximately 36.5% of pregnant women globally were affected in 2019, while Indonesian national data (Riskesdas 2018) indicated that 48.9% of pregnant women experienced anemia.[4,5] In the Sikumana Primary Health Center catchment area, local health data in 2022 documented that approximately 32% of pregnant women were affected by anemia.[6] Iron deficiency anemia represents the most common form during pregnancy and has been associated with adverse fetal outcomes, including intrauterine growth restriction, preterm birth, miscarriage, impaired physical and cognitive development, and low birth weight.[7]

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Low birth weight (LBW) remains a critical perinatal outcome of global concern. The World Health Organization estimated that 15–20% of infants worldwide are born with LBW, accounting for nearly 20 million births annually, with the majority occurring in developing countries.[8] In Indonesia, the prevalence of LBW was reported at 6.2%, with higher regional burdens observed in eastern provinces, including Nusa Tenggara Timur.[5,8,9] LBW is a major contributor to neonatal morbidity and mortality and has also been linked to an increased risk of non-communicable diseases later in life.[10]

From a biological perspective, maternal anemia may compromise oxygen transport and nutrient delivery to the fetus, thereby impairing fetal growth and increasing the likelihood of low birth weight.[11] Disruption of maternal–fetal exchange represents a central pathophysiological pathway linking anemia during pregnancy with adverse neonatal outcomes.[11]

Nevertheless, previous studies have demonstrated inconsistent findings. Research conducted in Supiori Hospital in 2022 and in Pasar Rebo Primary Health Center, East Jakarta in 2020 identified a significant association between maternal anemia and LBW.[12,13] In contrast, a study conducted across six primary health center regions in Semarang in 2019 reported no statistically significant relationship between anemia during pregnancy and LBW.[14] These discrepancies highlight the importance of generating context-specific evidence, particularly in regions with high anemia prevalence and limited maternal health resources.

Therefore, this study aimed to evaluate the association between anemia in third-trimester pregnant women and the incidence of low birth weight among newborns at Sikumana Primary Health Center, Kupang, Indonesia.[15]

METHODS

This study employed an observational analytic design with a prospective cohort approach to evaluate the association between maternal anemia during the third trimester of pregnancy and low birth weight among newborns. The research was conducted at Sikumana Primary Health Center, located in Maulafa District, Kupang City, East Nusa Tenggara Province, Indonesia. Data collection was carried out from July to September 2023 through direct assessment of pregnant women and follow-up until delivery.

The study population consisted of third-trimester pregnant women who routinely attended antenatal care services at the health center and their newborn infants. A total of 50 mother–infant pairs were included in the study. Participants were recruited using a consecutive sampling technique, in which all eligible pregnant women encountered during the study period were enrolled until the required sample size was achieved.

Pregnant women were included if they were in the third trimester of pregnancy, resided within the Sikumana Primary Health Center service area, attended routine antenatal care visits, and provided written informed consent. Exclusion criteria included multiple pregnancies, severe anemia requiring blood transfusion, and refusal to participate in the study. Participants were excluded from analysis if abortion, intrauterine fetal death, or loss to follow-up occurred during the study period.

The independent variable in this study was maternal anemia during the third trimester of pregnancy, while the dependent variable was neonatal birth weight. Maternal anemia was defined as a hemoglobin concentration below 11 g/dL. Low birth weight was defined as a neonatal birth weight of less than 2,500 grams measured within the first hour after delivery. Potential confounding variables considered in this study included maternal age, parity, educational level, frequency of antenatal care visits, and the presence of maternal infection.

Maternal hemoglobin levels were obtained through venous blood sampling performed under standard aseptic procedures and analyzed using an automated hematology analyzer. Neonatal birth weight data were collected from maternal and child health records or official birth documentation recorded shortly after delivery.

Data analysis was performed using statistical software. The normality of continuous variables was assessed using the Kolmogorov–Smirnov test. The association between maternal hemoglobin levels and neonatal birth weight was evaluated using Pearson correlation analysis. A p-value of less than 0.05 was considered statistically significant.

Ethical approval for this study was obtained from the Health Research Ethics Committee of the Faculty of Medicine and Veterinary Medicine, Universitas Nusa Cendana, Kupang, Indonesia (Ethics Approval Number: 11/UN15.16/KEPK/2023, approved on April

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14th, 2023). Written informed consent was obtained from all participants prior to enrollment. Participant confidentiality and anonymity were strictly maintained throughout the research process.

RESULTS

A total of 50 third-trimester pregnant women and their newborns were included in the final analysis. All enrolled participants completed follow-up until delivery, and no cases of abortion, intrauterine fetal death, or loss to follow-up were recorded during the study period.

Assessment of maternal hemoglobin levels demonstrated that 18 participants (36%) were classified as having anemia during the third trimester of pregnancy, while the remaining 32 participants (64%) exhibited hemoglobin concentrations within the normal range. Evaluation of neonatal outcomes showed that 20 newborns (40%) were delivered with low birth weight, defined as a birth weight below 2,500 grams, whereas 30 newborns (60%) had normal birth weight.

Further hematological evaluation among anemic pregnant women revealed heterogeneous erythrocyte morphology. Microcytic hypochromic patterns were observed in nine cases, while normocytic normochromic patterns were also identified in nine cases. No macrocytic morphology was detected among the study participants.

To examine the relationship between maternal hemoglobin concentration and neonatal birth weight, bivariate analysis was performed using Pearson correlation testing. The analysis demonstrated a statistically significant association between maternal hemoglobin level and birth weight ($p = 0.032$). The correlation coefficient value ($r = 0.304$) indicated a moderate positive correlation, suggesting that decreasing maternal hemoglobin levels were associated with an increased likelihood of low birth weight.

All distributions of maternal anemia status, neonatal birth weight outcomes, erythrocyte morphology, and correlation analysis are presented in Table 1.

Table 1. Distribution of maternal anemia, neonatal birth weight, erythrocyte morphology, and correlation analysis (n = 50)

Variable	Category	n	%
Maternal hemoglobin status	Anemia (Hb < 11 g/dL)	18	36
	Non-anemia (Hb ≥ 11 g/dL)	32	64
Neonatal birth weight	Low birth weight (< 2500 g)	20	40
	Normal birth weight (≥ 2500 g)	30	60
Erythrocyte morphology among anemic mothers (n = 18)	Microcytic hypochromic	9	50
	Normocytic normochromic	9	50
	Macrocytic	0	0
Correlation analysis	Pearson correlation coefficient (r)	0.304	—
	p value	0.032	—

DISCUSSION

This prospective cohort study demonstrated a statistically significant association between maternal anemia in the third trimester and low birth weight among newborns delivered at Sikumana Primary Health Center. The observed moderate correlation suggests that reduced maternal hemoglobin concentration during late pregnancy is associated with impaired fetal growth, particularly during a period characterized by increased metabolic demand and rapid fetal weight accretion.[15]

The findings of this study are consistent with previous investigations conducted in several regions of Indonesia, which reported a significant relationship between maternal anemia and low birth weight. Studies performed in Supiori Hospital and in primary health care settings in East Jakarta demonstrated that pregnant women with anemia had a higher likelihood of delivering infants with low birth weight.[12,13] In contrast, other studies conducted in different primary care regions did not identify a statistically

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significant association, indicating that the effect of maternal anemia on birth weight may vary depending on population characteristics, nutritional status, and the distribution of anemia severity.[14]

From a biological perspective, anemia during pregnancy reduces the oxygen-carrying capacity of maternal blood, potentially leading to chronic fetal hypoxia. Inadequate oxygen delivery may impair placental perfusion and reduce the efficiency of nutrient transfer to the fetus. These mechanisms can disrupt cellular proliferation and fetal tissue growth, thereby increasing the risk of low birth weight.[11] The impact of anemia may be particularly pronounced during the third trimester, when fetal growth velocity reaches its peak and oxygen requirements are substantially elevated.[1,2]

The erythrocyte morphology observed among anemic participants further reflects the heterogeneous nature of anemia in pregnancy. The presence of both microcytic hypochromic and normocytic normochromic patterns suggests that iron deficiency may coexist with other etiologies, such as early nutritional deficiency or anemia related to inflammatory conditions. Such heterogeneity may partly explain the variability of outcomes reported across different studies.[7]

Low birth weight remains a major determinant of neonatal morbidity and mortality, particularly in low-resource settings. Infants born with low birth weight are more susceptible to hypothermia, infection, feeding difficulties, and long-term growth and developmental impairment.[8-10] These consequences highlight the importance of identifying modifiable maternal risk factors during pregnancy.

The findings of the present study support the strengthening of antenatal care strategies aimed at early detection and appropriate management of maternal anemia. Routine hemoglobin screening, improved adherence to iron supplementation, and nutritional counseling may represent practical interventions to reduce the burden of low birth weight at the primary health care level.[6,7]

Several limitations should be acknowledged. The relatively small sample size may limit generalizability beyond the study setting. In addition, the absence of biochemical markers such as serum ferritin or inflammatory parameters restricts etiological classification of anemia. Potential residual confounding from maternal nutritional status, gestational age at delivery, and placental factors may also have influenced the observed association. Nevertheless, the prospective design and standardized laboratory assessment of hemoglobin strengthen the internal validity of this study.[16]

CONCLUSION

This study demonstrates a significant association between maternal anemia during the third trimester of pregnancy and low birth weight among newborns delivered at a primary health care setting. Lower maternal hemoglobin concentration was correlated with reduced neonatal birth weight, emphasizing the importance of adequate maternal hematological status during late pregnancy. Strengthening early detection and appropriate management of anemia through routine antenatal care may contribute to improved neonatal outcomes, particularly in regions with a high burden of maternal anemia.

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