

The Significant Association Between Maternal Anemia and the Incidence of Neonatal Asphyxia in Indonesia

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ABSTRACT

Neonatal asphyxia is a clinical condition in which a newborn fails to initiate spontaneous and regular breathing. According to the Indonesian Ministry of Health (2017), asphyxia accounts for 27.8% of neonatal mortality nationwide. Maternal anemia is recognized as one of the contributing factors, beginning with reduced hemoglobin (Hb) levels that impair oxygen transport and ultimately lead to fetal hypoxia. Although numerous studies have examined this association in Indonesia, the findings remain heterogeneous, indicating the need for a comprehensive synthesis of existing evidence. This literature review aims to systematically synthesize research conducted in Indonesia regarding the relationship between maternal anemia and neonatal asphyxia, thereby addressing existing gaps and clarifying the consistency of findings across studies. A narrative review approach was employed, supported by a systematic search across Google Scholar, PubMed, ScienceDirect, and Garuda. Predefined keywords included “maternal anemia”, “neonatal asphyxia”, and “Indonesia”. A total of 110 articles were initially identified. After applying inclusion and exclusion criteria, six studies were deemed eligible for analysis. Extracted data included study design, sample size, analytical methods, and statistical significance of the association between maternal anemia and neonatal asphyxia. Of the six included studies, five reported a statistically significant association between maternal anemia and neonatal asphyxia. One study found no significant relationship. Overall, the evidence suggests that decreased maternal Hb levels increase the risk of fetal hypoxia, which may culminate in asphyxia at birth. In conclusion, the majority of Indonesian studies indicate that maternal anemia is an important risk factor for neonatal asphyxia. These findings underscore the need for strengthened health education on adequate maternal nutrition and the importance of antenatal care (ANC) for early detection and management of anemia. Preventive strategies targeting maternal anemia may contribute to reducing perinatal complications, including neonatal asphyxia.

Keywords: maternal anemia; neonatal asphyxia; pregnancy; risk factors; Indonesia

INTRODUCTION

Neonatal asphyxia is a critical perinatal condition characterized by the inability of a newborn to initiate spontaneous and regular breathing immediately after birth [1–7]. This condition remains a major contributor to neonatal morbidity and mortality worldwide. In 2013, the World Health Organization (WHO) reported that the global incidence of neonatal asphyxia reached approximately 25 cases per 1,000 live births, underscoring its substantial public health burden [8]. In the Indonesian context, the Ministry of Health documented in 2017 that asphyxia accounted for 27.8% of all neonatal deaths, making it one of the leading causes of early-life mortality in the country [9]. These figures highlight the urgency of identifying and addressing modifiable maternal and perinatal risk factors associated with neonatal asphyxia.

One of the maternal conditions frequently linked to neonatal asphyxia is anemia gravidarum, or anemia during pregnancy. This condition disrupts the physiological capacity of the maternal bloodstream to transport oxygen effectively to the fetus. The pathological process typically begins with a decline in maternal hemoglobin (Hb) levels, which subsequently reduces oxygen-carrying capacity and impairs placental oxygen transfer. Over time, this insufficiency may culminate in fetal hypoxia, a precursor to intrapartum or immediate postpartum asphyxia [10]. WHO classified anemia in pregnancy as a global health concern in 2019, noting its persistently high prevalence in low- and middle-income countries. In Indonesia, the prevalence of anemia gravidarum increased between 2017 and 2019, reflecting ongoing nutritional, socioeconomic, and healthcare access challenges among pregnant women [11].

A growing body of empirical research has examined the association between maternal anemia and neonatal asphyxia. Studies conducted by Martini, Rahman et al., and Ulfah et al. consistently reported a statistically significant relationship, suggesting that maternal anemia increases the likelihood of asphyxia at birth. However, the evidence is not entirely uniform. Srinigrat et al., for example, documented no significant association, indicating potential variability across populations, methodological approaches, and contextual factors. These inconsistencies highlight the fragmented nature of existing evidence and the absence of a comprehensive synthesis that integrates findings across Indonesian studies.

Despite the number of studies conducted, the literature remains dispersed, with variations in study design, sample characteristics, diagnostic criteria, and analytical methods. Consequently, the overall strength and consistency of the association between maternal anemia and neonatal asphyxia in Indonesia remain unclear. To address this gap, the present literature review aims to systematically and explicitly synthesize research conducted within the Indonesian context. By consolidating available evidence, this review seeks to clarify the relationship between maternal anemia and neonatal asphyxia, identify patterns and discrepancies across studies, and provide a more coherent understanding that may inform maternal health interventions and neonatal risk reduction strategies.

METHODS

This study employed a literature review method with a narrative synthesis approach to identify and analyze research related to the relationship between maternal anemia and the incidence of neonatal asphyxia [12–16]. The article search process was conducted using the PIO framework (Population, Intervention/Exposure, Outcome), consisting of Population: pregnant women or women in labor; Intervention/exposure: maternal anemia; and Outcome: the incidence of neonatal asphyxia in newborns.

The literature search was conducted in March 2026 through four databases: Google Scholar, PubMed, ScienceDirect, and Garuda (Table 1). The search process utilized a combination of predefined keywords with the assistance of Boolean operators (AND, OR) [17,18]. The publication period was limited to 2016–2026 to obtain more up-to-date and clinically relevant scientific evidence.

Data extraction was performed by collecting essential information from each article, including the author(s), year of publication, study location, study design, analytical methods, sample size, and the main findings [19-21] related to the relationship between maternal anemia and the incidence of neonatal asphyxia.

Table 1. Databases and keywords

Databases	Keywords
Google Scholar	("maternal anemia" OR "anemia in pregnancy" OR "anemia gravidarum") AND ("neonatal asphyxia" OR "birth asphyxia") AND (Indonesia OR Indonesian)
PubMed	
Sciencedirect	
Garuda	("anemia pada ibu hamil") AND ("asfiksia neonatorum")

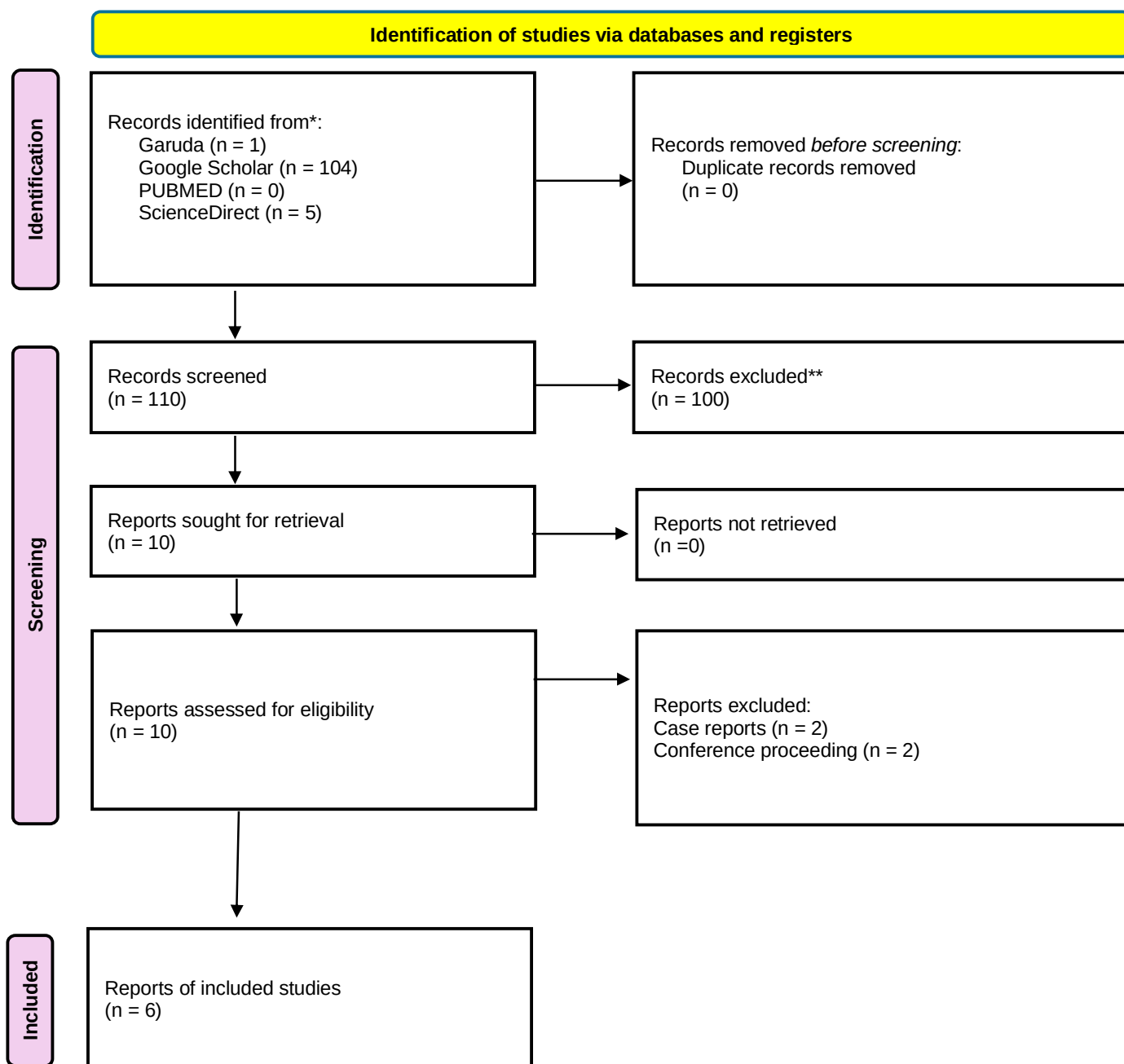


Figure 1. PRISMA flowchart

RESULTS

A total of six studies were included in this review, consisting of three cross-sectional and three case-control studies. The studies were conducted in various regions of Indonesia, including Java, Sumatra, Bali, and Kalimantan. The majority of studies demonstrated a consistent positive association between maternal anemia and neonatal asphyxia, suggesting a potential relationship across different populations and study settings. Most studies (5 out of 6) reported a statistically significant association between maternal anemia and neonatal asphyxia, while one study found no significant relationship. The summary of the included studies is presented in Table 1.

Table 1. Data extraction

Author, year	Design	Analysis	Sample size	Location, city	Results
Martini, 2021 [22]	Cross-sectional	Chi-square	132	Permata Bunda Hospital, Purwodadi	There is a relationship between maternal anemia during pregnancy and the incidence of neonatal asphyxia ($p = 0.005$).
Rahman et al., 2022 [23]	Case-control	Chi-square	130	Abdoel Wahab Sjahranie Regional Hospital, Samarinda	There is a relationship between a maternal history of anemia and the incidence of newborns with Apgar score < 7 ($p = 0.001$).
Sriningrat et al., 2025 [24]	Case-control	Fisher's Exact Test	189	Wangaya Regional Hospital, Denpasar	No significant relationship was found between maternal anemia and the incidence of neonatal asphyxia ($p = 0.617$).
Sharief et al., 2026 [25]	Cross-sectional	Chi-square	160	Dr. Wahidin Sudirohusodo General Hospital, Makassar	There is a relationship between the degree of anemia in the third trimester of pregnancy and maternal and perinatal outcomes ($p < 0.05$).
Ulfah et al., 2023 [26]	Cross-sectional	Chi-square	132	Dr. M. Djamil General Hospital, Padang	There is a significant relationship between prenatal anemia ($p = 0.035$) and the incidence of asphyxia.
Astuti & Yunita, 2020 [27]	Case-control	Chi-square	160	Regional Hospital of Sumatra Island, South Bengkulu	There is a significant relationship between the degree of anemia during pregnancy and the incidence of neonatal asphyxia ($p = 0.000$).

DISCUSSION

Most studies conducted in Indonesia consistently demonstrate a strong and statistically significant relationship between maternal anemia and the incidence of neonatal asphyxia. Research by Martini (2021), Rahman et al. (2022), Ulfah et al. (2023), Astuti and Yunita (2021), and Sharief et al. (2026) collectively reinforces the notion that anemia during pregnancy substantially elevates the risk of asphyxia in newborns. These studies, which vary in design, sample size, and regional representation, converge on the conclusion that reduced maternal hemoglobin levels compromise fetal oxygenation, thereby increasing the likelihood of respiratory failure at birth. Conversely, Sriningrat et al. (2025) reported no significant association, highlighting an important inconsistency in the existing body of evidence and suggesting that the relationship may be influenced by contextual, methodological, or population-specific factors [22,25–27].

From a physiological standpoint, maternal anemia initiates a cascade of pathophysiological events that ultimately impair oxygen delivery to both maternal and fetal tissues. The reduction in hemoglobin concentration diminishes the oxygen-carrying capacity of maternal blood, thereby limiting the amount of oxygen available for placental transfer. This impaired transport mechanism reduces uteroplacental perfusion, leading to chronic intrauterine hypoxia. Prolonged fetal exposure to hypoxic conditions increases the risk of neonatal asphyxia, particularly during the stress of labor and delivery. Martini (2021) [22] and Sharief et al. (2026) [25] emphasized that sustained hypoxia can precipitate multi-organ dysfunction, including cardiac compromise, neurological injury, and in severe cases, neonatal death. These findings underscore the critical importance of maintaining adequate maternal hematologic status throughout pregnancy to ensure optimal fetal oxygenation.

The pathophysiology of anemia in pregnancy is further complicated by the substantial physiological changes that occur during gestation. Pregnancy is characterized by a marked expansion of plasma volume, often exceeding 40% which can dilute hemoglobin concentration even in the presence of normal red blood cell mass. Additionally, iron requirements increase significantly due to fetal growth, placental development, and maternal erythropoiesis. Obeagu (2024) [28] and Bagaskoro et al. (2026) [29] noted that metabolic alterations, such as elevated hepcidin levels, can inhibit intestinal iron absorption, thereby exacerbating iron deficiency. Nutritional inadequacies, particularly deficiencies in folate and vitamin B12, further impair erythropoiesis and contribute to the development of anemia. These complex physiological and nutritional interactions illustrate why anemia gravidarum remains prevalent in low-resource settings and why its consequences can be severe.

The severity of maternal anemia plays a decisive role in determining neonatal outcomes. Astuti and Yunita (2021) [27] demonstrated that moderate to severe anemia is associated with a substantially higher risk of neonatal asphyxia compared to mild anemia. This heightened risk is attributed to the failure of compensatory mechanisms, such as increased cardiac output and enhanced placental blood flow to offset the reduced oxygen-carrying capacity. When these compensatory responses become insufficient, fetal oxygenation declines rapidly, increasing vulnerability to intrapartum hypoxic events. Furthermore, Ulfah et al. (2023) [26] highlighted that maternal anemia often interacts synergistically with other obstetric complications, including preeclampsia, intrauterine growth restriction, and preterm labor. These comorbid conditions amplify the risk of adverse neonatal outcomes by further compromising placental function and fetal oxygen supply.

The inconsistency observed in the findings of Sriningrat et al. (2025) [24] may be attributed to several methodological and contextual factors. Variations in study design, such as differences between cross-sectional, case-control, and cohort approaches can influence the strength and direction of observed associations. Sample size limitations may reduce statistical power, while differences in diagnostic criteria for anemia and asphyxia can lead to misclassification bias. Additionally, disparities in antenatal care quality across regions may affect both maternal hematologic status and neonatal outcomes. Wang et al. (2025) [30] suggested that in certain populations, factors such as fetal organ maturity, intrapartum monitoring, and delivery management may exert a greater influence on neonatal respiratory outcomes than maternal hemoglobin levels alone. These insights highlight the multifactorial nature of neonatal asphyxia and the need for comprehensive approaches to maternal and neonatal health.

Sociodemographic determinants also play a pivotal role in shaping maternal anemia risk. Martini (2021) [22] emphasized that maternal age, educational attainment, socioeconomic status, and access to nutritional resources significantly influence adherence to iron supplementation and dietary recommendations. Younger mothers, those with limited education, and those living in low-income households are more likely to experience nutritional deficiencies and inadequate antenatal care, thereby increasing their susceptibility to anemia. Addressing these sociodemographic disparities is essential for reducing the prevalence of maternal anemia and improving neonatal outcomes.

A notable limitation of this review is the reliance on cross-sectional and case-control designs in the primary studies, which restricts the ability to establish definitive causality. These designs are inherently limited in their capacity to determine temporal relationships between exposure and outcome. Future research employing longitudinal cohort designs or randomized controlled trials would provide stronger evidence regarding the causal pathways linking maternal anemia to neonatal asphyxia. Additionally, standardized diagnostic criteria and uniform methodological approaches would enhance comparability across studies and strengthen the overall evidence base.

CONCLUSION

This review found that asphyxia is significantly associated with maternal anemia. Preventive efforts through early detection of anemia during pregnancy, adequate iron intake, and improved quality of antenatal care should be strengthened to reduce the risk of neonatal complications. Further research using stronger study designs, such as cohort or longitudinal studies, is recommended to better establish causal relationships.

Ethical consideration, competing interest and source of funding

- The ethical approval: This study no need ethical clearance because only comparing results of some studies that had been published open before (information of public domain). Every result of the involved studies had been mentioned in the citation and references, include the name of the authors, title of the journal and year of publication.
- There is no conflict of interest related to this publication.
- Source of funding is authors.

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