Research Article

Maternal Anemia and Low Birth Weight Among Term Singleton Deliveries at a Tertiary Hospital

Rizky Nurwan Diyanto,[1] Yudi Mulyana Hidayat,[2] Budi Handono[3]
[1]Department of Obstetrics and Gynecology, Faculty of Medicine, Universitas Padjadjaran – Dr. Hasan Sadikin General Hospital, Bandung, Indonesia
[2]Gynecologic Oncology Division, Department of Obstetrics and Gynecology, Faculty of Medicine, Universitas Padjadjaran – Dr. Hasan Sadikin General Hospital, Bandung, Indonesia
[3]Maternal-Fetal Medicine Division, Department of Obstetrics and Gynecology, Faculty of Medicine, Universitas Padjadjaran – Dr. Hasan Sadikin General Hospital, Bandung, Indonesia
Correpondence: Rizky Nurwan Diyanto, Email: rizky12011@mail.unpad.ac.id
Received: September 18, 2026 | Revised: October 21, 2026 | Accepted: October 30, 2026 | Available Online: November 17, 2026 | Published: November 17, 2026
Indonesian Journal of Obstetrics & Gynecology Science. 2026;9(3): 534–540

Abstract
Objective: To assess the association between maternal anemia and low birth weight (LBW) among term singleton deliveries at a tertiary hospital in Indonesia.
Methods: This retrospective cross-sectional study used medical records from RSUP Dr. Hasan Sadikin Bandung during 2024–2025. Third-trimester Hb measurements were used to classify anemia as Hb <11 g/dL. LBW was defined as birth weight <2,500 g. Associations were assessed using Pearson chi-square, prevalence ratios (PRs) with 95% confidence intervals (CIs), and the Fisher-Freeman-Halton exact test for anemia severity. Adjusted PRs were estimated using modified Poisson regression.
Results: Among 953 records, 872 term singleton deliveries were analyzed. Anemia occurred in 314 (36.0%) mothers and LBW in 154 (17.7%) infants. Anemia was not significantly associated with LBW (crude PR 0.93, 95% CI 0.69–1.26; $p = 0.650$). Anemia severity was also not significantly associated with LBW ($p = 0.409$). After adjustment, the association remained non-significant (adjusted PR 0.82, 95% CI 0.61–1.12; $p = 0.210$).
Conclusion: No statistically significant association between maternal anemia and LBW was observed among term singleton deliveries in this study.

Keywords: Maternal anemia; hemoglobin; low birth weight; term delivery; singleton birth

Hubungan Anemia dengan Berat Badan Lahir Rendah pada Persalinan Tunggal di Rumah Sakit Tersier

Abstrak
Tujuan: Untuk menganalisis hubungan antara anemia ibu dan berat badan lahir rendah (BBLR) pada persalinan tunggal cukup bulan di rumah sakit tersier di Indonesia.
Metode: Penelitian potong lintang retrospektif ini menggunakan data rekam medis di RSUP Dr. Hasan Sadikin Bandung selama 2024–2025. Pemeriksaan Hb trimester ketiga digunakan untuk menentukan anemia dengan batas Hb <11 g/dL. BBLR didefinisikan sebagai berat badan lahir <2.500 g. Hubungan dianalisis menggunakan chi-square Pearson, Rasio Prevalensi (RP) dengan Interval Kepercayaan (IK) 95%, dan uji eksak Fisher-Freeman-Halton untuk derajat anemia. PR tersesuaikan dianalisis menggunakan regresi Poisson termodifikasi.
Hasil: Berdasarkan 953 rekam medis, 872 persalinan tunggal cukup bulan dianalisis. Anemia ditemukan pada 314 (36,0%) ibu dan BBLR pada 154 (17,7%) bayi. Anemia tidak berhubungan secara bermakna dengan BBLR (PR kasar 0,93; IK 95% 0,69–1,26; $p = 0,650$). Derajat anemia juga tidak berhubungan secara bermakna dengan BBLR ($p = 0,409$). Setelah penyesuaian, hubungan tetap tidak bermakna (PR tersesuaikan 0,82; IK 95% 0,61–1,12; $p = 0,210$).
Kesimpulan: Tidak ditemukan bukti statistik adanya hubungan antara anemia ibu dan BBLR pada persalinan tunggal cukup bulan dalam penelitian ini.

Kata kunci: Anemia ibu; hemoglobin; berat badan lahir rendah; persalinan cukup bulan; persalinan tunggal

Indonesian Journal of Obstetrics & Gynecology Science is licensed under a Creative Commons Attribution-ShareAlike 4.0 International License (https://creativecommons.org/licenses/by-sa/4.0/) **DOI: 10.24198/obgynia.v9i3.1287**

Introduction

Maternal anemia remains a common health problem during pregnancy, particularly in low- and middle-income countries.[1] The World Health Organization defines anemia in pregnancy as a hemoglobin (Hb) concentration below 11 g/dL.[2] Its prevalence varies between populations and may be influenced by nutritional status, infection, and access to antenatal care. In Indonesia, the 2018 Basic Health Research reported anemia in 48.9% of pregnant women, highlighting its continued importance as a maternal health concern.[3]

Low birth weight (LBW), defined as a birth weight below 2,500 g, is an important contributor to neonatal morbidity and mortality.[4] Maternal anemia has been proposed as a possible contributor to impaired fetal growth through reduced oxygen-carrying capacity and changes in uteroplacental function.[5] Several systematic reviews and observational studies have reported an association between maternal anemia and LBW,[6] with stronger associations generally reported among women with moderate or severe anemia.[7] However, findings have not been consistent. Differences in anemia severity, timing of Hb assessment, population characteristics, and potential confounding factors may partly explain these differences.

Gestational age is an important consideration when studying maternal anemia and LBW because pre-term birth is strongly associated with low birth weight.[8] Studies that include both preterm and term births may therefore make it difficult to distinguish the relationship between maternal anemia and birth weight among infants born at term.[9] Evidence focusing specifically on term births remains relatively limited, particularly in Indonesian tertiary hospital settings.

A tertiary hospital provides an important clinical setting for examining maternal anemia and birth outcomes because it manages a wide range of obstetric cases. However, evidence on the relationship between maternal anemia and LBW specifically among term singleton deliveries in Indonesia remains limited.[10] Therefore, this study aimed to assess the association between maternal anemia and LBW among term singleton deliveries at a tertiary hospital in Indonesia during 2024–2025.

Methods

This retrospective analytic cross-sectional study used medical record data from deliveries at RSUP Dr. Hasan Sadikin Bandung during 2024–2025. Total sampling was applied to eligible records. A total of 953 delivery records were initially identified. Records with a gestational age of <37 weeks were excluded. Of the remaining 878 records, six were excluded because of invalid or missing maternal Hb and/or birth-weight data, resulting in 872 term singleton deliveries for analysis.

The primary exposure was maternal anemia based on the Hb measurement recorded in the medical record. All Hb measurements used for anemia classification were obtained during the third trimester. Anemia was defined as an Hb concentration of <11 g/dL according to the World Health Organization.[11] Anemia severity was classified as mild (Hb 9–10.9 g/dL), moderate (Hb 7–8.9 g/dL), or severe (Hb <7 g/dL). Mothers with an Hb concentration of ≥11 g/dL were classified as having no anemia. The outcome was LBW, defined as a birth weight of <2,500 g.[4]

Maternal age, body mass index (BMI), gestational age, parity, infant sex, and type of delivery were extracted from the medical records. These variables were used to describe the study population, while maternal age, BMI, gestational age, parity, and infant sex were included as covariates in the adjusted analysis. The timing of Hb measurement was recorded as third trimester for all included

observations. The study used the available medical records and did not include serial Hb measurements.

Categorical variables were summarized using frequencies and percentages, while continuous variables were summarized using means and standard deviations. The association between maternal anemia and LBW was initially assessed using the Pearson chi-square test. Crude prevalence ratios (PRs) with 95% confidence intervals (CIs) were calculated to quantify the association. Because of sparse expected cell counts in the anemia-severity analysis, the Fisher-Freeman-Halton exact test was used to assess the association between anemia severity and LBW.

A multivariable modified Poisson regression with robust variance was used to estimate adjusted PRs and 95% CIs. Maternal age, BMI, gestational age, parity, and infant sex were included as covariates based on their clinical relevance and availability in the dataset. BMI data were missing for 14 participants; therefore, the adjusted analysis used complete cases and included 858 observations. No a priori sample-size calculation was performed because total sampling of available eligible medical records was used. A p value of <0.05 was considered statistically significant.

The study was approved by the Ethics Committee of RSUP Dr. Hasan Sadikin Bandung under approval number DP.04.03/D. XIII.13/136/2026.

Results

Of the 953 delivery records initially identified, 878 had a gestational age of ≥37 weeks. Six additional records were excluded because of invalid or missing Hb and/or birth-weight data, resulting in 872 term singleton deliveries for analysis. Table 1 shows that most mothers were aged 20–35 years and were multigravida. Cesarean delivery was more common than vaginal delivery. The mean maternal Hb level was 11.30 ± 1.46 g/dL, and 36.0% of mothers had anemia. Most anemia cases were mild. The mean birth weight was 2,857.9 ± 473.1 g, and 17.7% of infants had LBW.

Table 1 Characteristics of The Study Population (n = 872)

Characteristic	n (%) or mean ± SD
Maternal age, years	29.1 ± 6.3
<20	57 (6.5)
20–35	670 (76.8)
>35	145 (16.6)
Parity	
Primigravida	302 (34.6)
Multigravida	502 (57.6)
Grand multigravida	68 (7.8)
Type of delivery	
Vaginal	329 (37.7)
Cesarean	543 (62.3)
Maternal Hb, g/dL	11.30 ± 1.46
Anemia, Hb <11 g/dL	314 (36.0)
No anemia, Hb ≥11 g/dL	558 (64.0)
Severe, Hb <7 g/dL	5 (0.6)
Moderate, Hb 7–8.9 g/dL	47 (5.4)
Mild, Hb 9–10.9 g/dL	262 (30.0)
Birth weight, g	2,857.9 ± 473.1
LBW, <2,500 g	154 (17.7)
≥2,500 g	718 (82.3)
Infant sex	
Male	445 (51.0)
Female	427 (49.0)

The distribution of LBW according to maternal anemia is shown in Table 2. LBW occurred in 53 (16.9%) infants born to mothers with anemia and 101 (18.1%) infants born to mothers without anemia. Pearson chi-square analysis showed no statistically significant association between maternal anemia and LBW. The crude PR was 0.93 (95% CI 0.69–1.26; p = 0.650).

Table 2 LBW According to Maternal Anemia Status

Maternal anemia status	LBW, n (%)	Birth weight ≥2,500 g, n (%)	Total, n
Anemia, Hb <11 g/dL	53 (16.9)	261 (83.1)	314
No anemia, Hb ≥11 g/dL	101 (18.1)	457 (81.9)	558
Total	154	718	872

Pearson chi-square, p = 0.650; crude PR 0.93, 95% CI 0.69–1.26.

Table 3 LBW According to Anemia Severity

Maternal anemia status	LBW, n (%)	Birth weight ≥2,500 g, n (%)	Total, n
Severe, Hb <7 g/dL	2 (40.0)	3 (60.0)	5
Moderate, Hb 7–8.9 g/dL	9 (19.1)	38 (80.9)	47
Mild, Hb 9–10.9 g/dL	42 (16.0)	220 (84.0)	262
No anemia, Hb ≥11 g/dL	101 (18.1)	457 (81.9)	558
Total	154	718	872

Fisher-Freeman-Halton exact test, p = 0.409.

The distribution of LBW according to anemia severity is presented in Table 3. LBW was observed in 2 (40.0%) infants born to mothers with severe, 9 (19.1%) moderate, and 42 (16.0%) with mild anemia. The Fisher-Freeman-Halton exact test showed no statistically significant association between anemia severity and LBW (p = 0.409). The severe anemia group consisted of only five mothers.

In the multivariable analysis, maternal anemia remained not significantly associated with LBW after adjustment for maternal age, BMI, gestational age, parity, and infant sex. The adjusted PR was 0.82 (95% CI 0.61–1.12; $p = 0.210$). The adjusted analysis included 858 complete cases because BMI data were unavailable for 14 participants. Overall, neither maternal anemia nor anemia severity showed a statistically significant association with LBW among the term singleton deliveries included in this study.

Discussion

This study did not find statistical evidence of an association between maternal anemia and LBW among term singleton deliveries at a tertiary hospital in Indonesia. The crude analysis showed a PR of 0.93, while the adjusted analysis showed a PR of 0.82. Both confidence intervals included 1, and neither analysis reached statistical significance. The same was observed when anemia was examined according to severity.

These findings differ from several previous studies and systematic reviews that have reported an association between maternal anemia and LBW. Differences in study populations, anemia definitions, timing of Hb assessment, gestational age, and adjustment for potential confounders may contribute to these inconsistent findings.[12] The present study focused specifically on term singleton deliveries, reducing the influence of prematurity on birth weight. This population may therefore differ from studies that included both term and preterm births.[1,13]

The timing of Hb assessment is also relevant. In this study, all Hb measurements used for classification were obtained during the third trimester. This provides a more defined exposure window than a dataset containing Hb measurements from different stages of pregnancy. However, a single third-trimester measurement does not capture the duration of anemia or changes in Hb levels throughout pregnancy. The relationship between earlier maternal anemia and subsequent fetal growth therefore cannot be

assessed from these data.

Anemia severity may also influence birth outcomes. Previous studies have suggested that adverse outcomes may be more apparent with moderate or severe anemia than with mild anemia.[14,15] In this study, most anemia cases were mild, while severe anemia was uncommon. Only five mothers had severe anemia, including two with LBW. This small subgroup limits the precision of comparisons by anemia severity and prevents meaningful conclusions about the effect of severe anemia.

Birth weight is influenced by multiple maternal, pregnancy-related, placental, and fetal factors. Nutritional status, BMI, gestational weight gain, hypertensive disorders, diabetes, infection, and placental function may all contribute to fetal growth.[16,17]and pregnancies in obese mothers have increased risk for complications including gestational diabetes, hypertensive disorders, pre-term birth and caesarian section. Children born to obese mothers are at increased risk of obesity and metabolic disease and are susceptible to develop neuropsychiatric and cognitive disorders. Changes in placental function not only play a critical role in the development of pregnancy complications but may also be involved in linking maternal obesity to long-term health risks in the infant. Maternal adipokines, i.e., interleukin 6 (IL-6 The adjusted analysis accounted for maternal age, BMI, gestational age, parity, and infant sex, but other potentially relevant factors were not consistently available for analysis. Residual and unmeasured confounding therefore remain possible.

The adjusted analysis produced a PR below 1, but the confidence interval included 1. This should not be interpreted as evidence of a protective effect of maternal anemia. Rather, the estimate indicates uncertainty around the direction and magnitude of the association after adjustment. The absence of statistical significance also does not establish that no association exists.

The retrospective design presents additional limitations. The study relied on existing medical records, which may contain incomplete information on factors relevant to maternal anemia and fetal growth. Although Hb timing was established as the third trimester for the measurements used in this study, serial Hb measurements were not available. In addition, BMI was missing for 14 participants and was handled through complete-case analysis in the adjusted model.

The study population was drawn from a tertiary referral hospital, where the clinical profile of patients may differ from that of the general obstetric population. The relatively high proportion of cesarean deliveries may also reflect the referral setting. These factors should be considered when generalizing the findings to other populations.

Despite these limitations, the study provides evidence on the relationship between maternal anemia and LBW specifically among term singleton deliveries in an Indonesian tertiary hospital. The findings do not demonstrate a statistically significant association in either the crude or adjusted analysis. Future prospective studies with serial Hb measurements and more complete information on nutritional, maternal, obstetric, and fetal factors may provide a clearer assessment of this relationship.

Conclusion

No statistically significant association between maternal anemia and LBW was observed among term singleton deliveries at a tertiary hospital in Indonesia during 2024–2025. The association remained statistically non-significant after adjustment for maternal age, BMI, gestational age, parity, and infant sex. These findings should be interpreted considering the retrospective design, third-trimester single Hb measurement, limited number of severe anemia cases, and potential residual or unmeasured confounding.

Acknowledgment

The authors express their gratitude to the Department of Obstetrics and Gynecology, Faculty of Medicine, Universitas Padjadjaran, RSUP Dr. Hasan Sadikin Bandung for their support and assistance in conducting this study.

Artificial Intelligence (AI) Usage Statement

Scopus AI was used during the literature search to identify potentially relevant literature for this study. The authors independently reviewed the identified literature and verified the information used in the manuscript. No AI tool was used for data analysis or interpretation.

Author Contribution Statement

RND contributed to conceptualization and initial drafting; YMH contributed to editing and manuscript revision; and BH contributed to supervision. All authors reviewed and approved the final manuscript.

Funding Statement

This research did not receive any specific grants from funding agencies in the public, commercial, or non-profit sectors. The study was self-funded by the authors.

Conflict of Interest

The authors declare that they have no conflicts of interest regarding this study.

Data Availability Statement

The data supporting the findings of this study are not publicly available due to privacy and confidentiality considerations regarding patient information. The data may be obtained from the corresponding author upon reasonable request and subject to applicable ethical and institutional restrictions.

References

1. Rahman MM, Abe SK, Rahman MS, et al. Maternal anemia and risk of adverse birth and health outcomes in low- and middle-income countries: systematic review and meta-analysis. *Am J Clin Nutr*. 2016;103(2):495–504. doi:10.3945/ajcn.115.107896
2. dos Santos CC, da Silva SL, Costa Caminha M de F, Maia SB, Figueiroa JN, Batista Filho M. Anemia in pregnant women according to two different assessment criteria (WHO versus CDC). *Int J Gynecol Obstet*. 2022;159(3):928–937. doi:10.1002/ijgo.14275
3. Margawati A, Syauqy A, Utami A, Adespin DA. Prevalence of Anemia and Associated Risk Factors among Pregnant Women in Semarang, Indonesia, during COVID-19 Pandemic. *Ethiop J Health Sci*. 2023;33(3):451–462. doi:10.4314/ejhs.v33i3.8
4. Manji KP. Low Birth Weight. In: *Neonatology for Medical Trainees*. Cham: Springer Nature Switzerland; 2026:3–26. doi:10.1007/978-3-032-26554-8_1
5. Obeagu GU, Altraide BO, Obeagu EI. Iron deficiency anemia in pregnancy and related complications with specific insight in Rivers State, Nigeria: a narrative review. *Ann Med Surg*. 2025;87(6):3435–3444. doi:10.1097/MS9.0000000000003224
6. Jung J, Rahman MM, Rahman MS, et al. Effects of hemoglobin levels during pregnancy on adverse maternal and infant outcomes: a systematic review and meta-analysis. *Ann N Y Acad Sci*. 2019;1450(1):69–82. doi:10.1111/nyas.14112
7. Figueiredo ACMG, Gomes-Filho IS, Silva RB, et al. Maternal Anemia and Low Birth Weight: A Systematic Review and Meta-

Analysis. *Nutrients*. 2018;10(5):601. doi:10.3390/nu10050601
8. Kumar KJ, Asha N, Murthy DS, Sujatha M, Manjunath V. Maternal anemia in various trimesters and its effect on newborn weight and maturity: an observational study. *Int J Prev Med*. 2013;4(2):193–199. http://www.ncbi.nlm.nih.gov/pubmed/23543625.
9. Rasmussen KM. Is There a Causal Relationship between Iron Deficiency or Iron-Deficiency Anemia and Weight at Birth, Length of Gestation and Perinatal Mortality? *J Nutr*. 2001;131(2):590S-603S. doi:10.1093/jn/131.2.590S
10. Koeryaman M, Rahayuwati L, Sari S, Mutyara K, Trisanto A. From Preconception to Postnatal: Parental Risk Factors for Fetal-Infant Growth Faltering in LMICs—a Scoping Review (2020–2025). *J Multidiscip Healthc*. 2026;Volume 19:1–13. doi:10.2147/JMDH.S573036
11. World Health Organization. *Guideline on haemoglobin cutoffs to define anaemia in individuals and populations*. World Health Organization; 2024.
12. Young MF, Oaks BM, Rogers HP, et al. Maternal low and high hemoglobin concentrations and associations with adverse maternal and infant health outcomes: an updated global systematic review and meta-analysis. *BMC Pregnancy Childbirth*. 2023;23(1):264. doi:10.1186/s12884-023-05489-6
13. Karimi P, Nourollahi Z, Nourollahi MM, Azami M. Maternal anemia and the risk of preterm birth: a meta-analysis. *J Matern Neonatal Med*. 2026;39(1). doi:10.1080/14767058.2026.2722830
14. Bahr TM, Lawrence SM, Henry E, Ohls RK, Li S, Christensen RD. Severe Anemia at Birth—Incidence and Implications. *J Pediatr*. 2022;248:39-45.e2. doi:10.1016/j.jpeds.2022.05.045
15. Obeagu GU, Obeagu EI. Complications of anemia in pregnancy: An updated overview for healthcare professionals. *Medicine (Baltimore)*. 2025;104(35):e44246. doi:10.1097/MD.0000000000044246
16. Howell KR, Powell TL. Effects of maternal obesity on placental function and fetal development. *Reproduction*. 2017;153(3):R97–R108. doi:10.1530/REP-16-0495
17. Wu G, Imhoff-Kunsch B, Girard AW. Biological Mechanisms for Nutritional Regulation of Maternal Health and Fetal Development. *Paediatr Perinat Epidemiol*. 2012;26(s1):4–26. doi:10.1111/j.1365-3016.2012.01291.x