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Anemia Status and Gestational Age Classification Among Women with Premature Rupture of Membranes at Bahteramas Regional General Hospital, Southeast Sulawesi, Indonesia

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A B S T R A C T

Background: *Anemia in pregnancy is associated with obstetric complications, including premature rupture of membranes (PROM). At Bahteramas Regional General Hospital, 132–163 PROM cases were recorded annually in 2020–2024.*

Objective: *To examine the association between anemia status and PROM classification (preterm, term and post-term) among women giving birth with PROM.*

Methods: *This observational cross-sectional study used secondary data from the emergency obstetric (PONEK) register and medical records of Bahteramas Regional General Hospital, Southeast Sulawesi, Indonesia. All women who gave birth with PROM in 2024 were included (total sampling; n = 142). Anemia was defined as hemoglobin <11.0 g/dL. Associations were tested with Pearson's chi-square test (α = 0.05).*

Results: *Anemia was present in 112 women (78.9%). Term PROM was the most frequent class (53.5%), followed by preterm (24.6%) and post-term PROM (21.8%). Among anemic women, 24.1%, 57.1% and 18.8% had preterm, term and post-term PROM, compared with 26.7%, 40.0% and 33.3% among non-anemic women; the difference was not significant ($\chi^2 = 3.667$; df = 2; p = 0.160; Cramér's V = 0.161). In an exploratory analysis, mean hemoglobin differed across PROM classes (preterm 9.34, term 9.55 and post-term 10.35 g/dL; p = 0.045).*

Conclusion: *Anemia was highly prevalent among women with PROM, but its distribution did not differ significantly across PROM classes. Because every participant had PROM, the study cannot determine whether anemia increases the risk of PROM; studies with a non-PROM comparison group are needed.*

1. INTRODUCTION

Anemia remains one of the most common medical disorders of pregnancy. In 2019, an estimated 36% of pregnant women aged 15–49 years worldwide were anemic, and the burden was highest in low- and middle-income countries (Stevens et al., 2022; World Health Organization, 2023). The World Health Organization (WHO) defines anemia in pregnancy as a hemoglobin concentration below 11.0 g/dL, and its 2024 guideline lowered the second-trimester cut-off to 10.5 g/dL (World Health Organization, 2024). In Indonesia, the 2023 Indonesian Health Survey reported an anemia prevalence of 27.7% among pregnant women (Ministry of Health of the Republic of Indonesia, 2023). National and regional studies have linked anemia in Indonesian women to undernutrition, low adherence to iron supplementation and inherited hemoglobin disorders such as β-thalassemia trait (Nainggolan et al., 2022; Seu et al., 2019).

Maternal anemia is associated with a wide range of adverse outcomes. Meta-analyses have linked low maternal hemoglobin with preterm birth, low birth weight, stillbirth, perinatal and neonatal mortality, and pre-eclampsia (Rahman et al., 2016; Young et al., 2023), and anemia is among the strongest risk factors for postpartum hemorrhage (Yunas et al., 2025). A 2025 meta-analysis of 31 cohort studies also found that anemic women had almost twice the risk of premature rupture of membranes (PROM) (relative risk 1.94; 95% CI 1.26–3.00) (Wang et al., 2025). The relationship is not linear: both low and high hemoglobin concentrations are

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associated with adverse birth outcomes, and the strength of the association depends on the trimester in which hemoglobin is measured (Dewey & Oaks, 2017; Young et al., 2023).

PROM is the rupture of the fetal membranes before the onset of labor; when it occurs before 37 completed weeks of gestation it is termed preterm PROM (PPROM) (American College of Obstetricians and Gynecologists, 2020). In the United States, PPROM complicates about 2–3% of pregnancies and term PROM about 8% (American College of Obstetricians and Gynecologists, 2020), and PPROM precedes 40–50% of all preterm births (Menon & Richardson, 2017). Its pathogenesis is multifactorial. Inflammation, oxidative stress, ascending infection and activation of matrix metalloproteinases weaken the collagen network of the amniochorion (Menon & Richardson, 2017; Tchirikov et al., 2018). Anemia and iron deficiency have been proposed to contribute through tissue hypoxia, maternal and fetal stress responses that stimulate corticotropin-releasing hormone, and greater susceptibility to infection (Allen, 2000). Established risk factors for PROM include prior PROM, previous preterm birth, low body mass index, reproductive tract infection, abnormal vaginal discharge and fetal malpresentation (Daniel et al., 2023; Lin et al., 2024).

Evidence on anemia and PROM comes largely from low- and middle-income settings. In Ethiopia, a meta-analysis and a recent case–control study found that hemoglobin below 11 g/dL was associated with PPROM (pooled odds ratio 3.97 and adjusted odds ratio 2.68, respectively) (Gebre et al., 2025; Geremew et al., 2024). A nested case–control study in China linked gestational anemia with PROM (Sun et al., 2021), and 32% of women presenting with PPROM at a tertiary hospital in Pakistan were anemic (Khan & Khattak, 2024). In Indonesia, hospital and primary care studies have reported significant associations between anemia and PROM (Nur Fatimah et al., 2022; Prastina, 2023; Rahmadeni & Hayat, 2022; Salim et al., 2024), while PROM itself more than doubles the risk of preterm labor (Sari et al., 2020).

Most of these studies compared women with and without PROM. Less is known about whether anemia differs across PROM classes defined by gestational age (preterm, term and post-term), which differ in clinical risk and management (American College of Obstetricians and Gynecologists, 2020). At Bahteramas Regional General Hospital, the provincial referral hospital of Southeast Sulawesi, the emergency obstetric (PONEK) register recorded 132–163 PROM cases each year in 2020–2024, equivalent to 17.6%–24.3% of 602–767 annual births. In 2024, 142 PROM cases and 361 cases of anemia were recorded among 674 births. This study therefore examined the association between anemia status and PROM classification (preterm, term and post-term) among women giving birth with PROM at Bahteramas Regional General Hospital in 2024.

2. METHODS

2.1 Study Design, Setting And Period

This was a quantitative observational study with a cross-sectional design based on secondary data. It was conducted at Bahteramas Regional General Hospital, Southeast Sulawesi Province, Indonesia, in June 2025.

2.2 Population and Sample

The population comprised all women who gave birth with PROM and were recorded in the PONEK emergency obstetric register of Bahteramas Regional General Hospital in 2024 (n = 142). Total sampling was applied, so all 142 women were included in the analysis.

2.3 Variables, Instruments and Operational Definitions

The independent variable was anemia status (anemic or not anemic), based on the hemoglobin concentration recorded in the medical record. Anemia was defined as hemoglobin <11.0 g/dL and was graded as mild (10.0–10.9 g/dL), moderate (7.0–9.9 g/dL) or severe (<7.0 g/dL) (World Health Organization, 2024). The dependent variable was PROM classification according to gestational age at membrane rupture: preterm (<37 weeks) (American College of Obstetricians and Gynecologists, 2020), term (37–41 weeks) and post-term (≥42 weeks). Maternal age, education, occupation and parity were also recorded. Data were extracted from the register and medical records with a structured data-extraction form.

2.4 Data Processing and Analysis

Data were edited, coded, entered, cleaned and tabulated. Descriptive results are presented as frequencies and percentages. The association between anemia status and PROM classification was tested with Pearson's chi-square test ($\alpha = 0.05$), and Cramér's V was reported as the effect size. As an additional exploratory analysis, hemoglobin concentrations were compared across PROM classes with the Kruskal–Wallis test. Analyses were performed with IBM SPSS Statistics version 26.

2.5 Ethical Considerations

The study used anonymized secondary data from hospital records. Permission to collect data was granted by the Director of Bahteramas Regional General Hospital, and ethical approval was obtained from [name of ethics committee] (approval No. [number]). Individual consent was not required because no identifiable information was collected.

3. RESULTS

3.1 Characteristics of Respondents

Most respondents were aged 20–35 years (79.6%), had completed senior high school (52.8%) and were housewives (82.4%). Primiparous women formed the largest parity group (33.8%) (Table 1).

Table 1. Characteristics of women giving birth with PROM (N = 142)

Characteristic	n	%
Age		
<20 years	9	6.3
20–35 years	113	79.6
>35 years	20	14.1
Education		
Primary school	11	7.7
Junior high school	28	19.7
Senior high school	75	52.8
Higher education	28	19.7
Occupation		
Housewife	117	82.4
Private sector employee	10	7.0
Civil servant/other[a]	15	10.6
Parity		
1	48	33.8
2	41	28.9
3	24	16.9
≥4	29	20.4

Source: secondary data, Bahteramas Regional General Hospital, 2024. [a]Includes contract staff, physicians, pharmacists and nurses.

3.2 Anemia and PROM Classification

Anemia was present in 112 women (78.9%): mild in 49 (34.5%), moderate in 43 (30.3%) and severe in 20 (14.1%); 30 women (21.1%) were not anemic. Mean hemoglobin was 9.67 ± 1.83 g/dL (range 6.5–13.5 g/dL). By PROM class, 76 women (53.5%) had term PROM, 35 (24.6%) preterm PROM and 31 (21.8%) post-term PROM.

3.3 Association between Anemia Status and PROM Classification

The proportion of term PROM was higher among anemic than non-anemic women (57.1% vs. 40.0%), whereas the proportion of post-term PROM was lower (18.8% vs. 33.3%); the proportion of preterm PROM was similar (24.1% vs. 26.7%). These differences were not statistically significant ($\chi^2 = 3.667$; df = 2; p = 0.160), and the effect size was small (Cramér's V = 0.161) (Table 2). No cell had an expected count below 5.

Table 2. Anemia status by PROM classification

Anemia status	Preterm n (%)	Term n (%)	Post-term n (%)	Total n (%)	p
Anemic	27 (24.1)	64 (57.1)	21 (18.8)	112 (100)	
Not anemic	8 (26.7)	12 (40.0)	10 (33.3)	30 (100)	0.160
Total	**35 (24.6)**	**76 (53.5)**	**31 (21.8)**	**142 (100)**	

Pearson's chi-square test, df = 2; row percentages. Source: processed secondary data.

In the exploratory analysis, hemoglobin concentrations differed across PROM classes (Kruskal–Wallis H = 6.208; df = 2; p = 0.045). Mean hemoglobin was lowest in preterm PROM and highest in post-term PROM (Table 3).

Table 3. Hemoglobin concentration by PROM classification (exploratory analysis)

PROM classification	n	Mean ± SD (g/dL)
Preterm	35	9.34 ± 2.18
Term	76	9.55 ± 1.68
Post-term	31	10.35 ± 1.64

Kruskal–Wallis test, p = 0.045. This analysis was not pre-specified and was not corrected for multiple comparisons.

4. DISCUSSION

The main finding of this study is the very high proportion of anemia among women giving birth with PROM (78.9%). This is far above the national prevalence among pregnant women in Indonesia (27.7%) (Ministry of Health of the Republic of Indonesia, 2023) and the global estimate of 36% (Stevens et al., 2022). The comparison must be interpreted cautiously, because the sample came from a single referral hospital and consisted entirely of women with PROM, so it cannot be compared directly with population prevalence. The proportion is also higher than the 32% reported among women with PPROM in Pakistan (Khan & Khattak, 2024). Differences in the timing of hemoglobin measurement (antenatal or at admission for delivery), a referral case mix weighted towards complicated pregnancies, and regional factors may explain the gap. In eastern Indonesia, low adherence to iron tablets and a high frequency of β-thalassemia trait have been documented (Seu et al., 2019), and adherence to iron–folic acid supplementation depends on parity and on women's knowledge of anemia and supplementation (Saragih et al., 2022).

Anemia status did not differ significantly across PROM classes (p = 0.160). This result answers a different question from earlier studies that reported an association between anemia and PROM (Gebre et al., 2025; Geremew et al., 2024; Nur Fatimah et al., 2022; Prastina, 2023; Rahmadeni & Hayat, 2022; Salim et al., 2024; Wang et al., 2025). Those studies compared women with and without PROM or estimated the incidence of PROM by anemia status, whereas the present study included only women who already had PROM and compared PROM types by gestational age. Our results therefore neither support nor refute those findings, and they cannot be used to conclude that anemia does or does not cause PROM. The absence of a concentration of anemia in preterm PROM also differs from Ethiopian evidence linking low hemoglobin specifically with PPROM (Gebre et al., 2025; Geremew et al., 2024). The small number of non-anemic women (n = 30) limited statistical power, and the small

effect size (Cramér's V = 0.161) indicates that a larger sample would be needed to detect modest differences.

Biologically, anemia may contribute to PROM through tissue hypoxia, stress-related increases in corticotropin-releasing hormone and greater vulnerability to infection (Allen, 2000), which act on fetal membranes already exposed to inflammation, oxidative stress and matrix metalloproteinase activity (Menon & Richardson, 2017; Tchirikov et al., 2018). These mechanisms were not measured in this study and serve only as an explanatory framework, not as findings supported by our data. The high proportions of moderate (30.3%) and severe (14.1%) anemia nevertheless matter clinically. Low maternal hemoglobin is associated with preterm birth, low birth weight and perinatal death (Rahman et al., 2016; Rugumisa et al., 2021; Young et al., 2023), and anemia strongly increases the risk of postpartum hemorrhage (Yunas et al., 2025), a particular concern for women with PROM who may require induction or operative delivery (American College of Obstetricians and Gynecologists, 2020).

In the exploratory analysis, hemoglobin tended to be lower in preterm PROM and higher in post-term PROM. This pattern may reflect physiological changes in hemoglobin across gestation, since plasma volume expansion exceeds the increase in red cell mass and causes hemodilution (Soma-Pillay et al., 2016). It may also reflect a true link between low hemoglobin and earlier membrane rupture. The timing of measurement matters, because associations between low hemoglobin and adverse birth outcomes are strongest when hemoglobin is measured early in pregnancy (Dewey & Oaks, 2017). Because this analysis was not pre-specified, did not adjust for confounders and produced a p-value close to the significance threshold ($p = 0.045$), the finding should be regarded only as hypothesis-generating.

From a service perspective, the findings support systematic anemia screening at antenatal visits, preventive iron supplementation for all pregnant women and early treatment of iron-deficiency anemia, as recommended by an Asian expert consensus (Pai et al., 2023). Antenatal multiple micronutrient supplementation has also shown benefits for birth outcomes compared with iron–folic acid alone in low- and middle-income countries (Oh et al., 2020). Counselling that improves women's knowledge of anemia and supplementation is likely to improve adherence (Saragih et al., 2022).

LIMITATIONS

This study has several limitations. First, there was no comparison group without PROM, so the risk of PROM associated with anemia (for example, an odds ratio) could not be estimated. Second, data came from medical records, so the timing of hemoglobin measurement (antenatal or on admission for delivery) and the gestational age at measurement were not uniform and could not be verified. Third, other potential confounders, such as maternal age, parity, genital tract infection, multiple pregnancy, fetal presentation and previous PROM (Daniel et al., 2023; Lin et al., 2024), were not analysed. Fourth, the study was conducted in a single hospital, which limits generalizability.

5. CONCLUSION

Anemia was found in 78.9% of women giving birth with PROM at Bahteramas Regional General Hospital in 2024, but its distribution did not differ significantly across PROM classes ($p = 0.160$). Because all participants had PROM, the study cannot establish a causal relationship between anemia and PROM. Future studies should use case–control or cohort designs with a non-PROM comparison group, standardized hemoglobin measurements by gestational age and multivariable analysis. For health services, the high proportion of anemia underlines the need for early detection of anemia during antenatal care, nutritional counselling and adherence to iron supplementation.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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