**Journal of Pioneering Medical Sciences**
Received: August 30, 2026 | Accepted: September 12, 2026 | Published: November 15, 2026
Volume 15, Issue S02, Pages 261-265

*DOI https://doi.org/10.47310/jpms202615S0230*




# Maternal Anemia and Neonatal Outcomes in Sudan: Data Provenance and Analysis Requiring Verification

**Khalid Albasheer**[1*]
[1]Department of Obstetrics and Gynecology, College of Medicine, Prince Sattam Bin Abdulaziz University, Al-kharj 11942, Saudi Arabia

*Corresponding author: Khalid Albasheer (e-mail: k.albasheer@psau.edu.sa).

©2026 the Author(s). This is an open access article distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/4.0

**Abstract** **Objectives:** Maternal anemia is an important concern in Sudan. This manuscript examines reported associations between anemia, low birth weight, and preterm birth. The provenance of the numerical dataset requires verification before the work can be described as an original prospective cohort. **Methods:** The source manuscript describes a hospital-based cohort of 215 women aged 18–45 years with singleton pregnancies in Sudan and reports consecutive recruitment. However, the hospital identity, recruitment dates, ethics approval, screening and follow-up counts, and authenticity of the underlying participant-level observations have not been documented in the materials supplied for revision. **Results:** In the unverified tabulation (n = 215), 91 women (42.3%) were categorized as anemic and 124 (57.7%) as non-anemic. Low birth weight was recorded for 23/91 (25.3%) versus 12/124 (9.7%), preterm birth for 22/91 (24.2%) versus 14/124 (11.3%). These are unadjusted descriptive comparisons of the supplied counts and cannot establish clinical associations until source records and analyses are authenticated. NICU admissions (29) and neonatal deaths (5) are available only as overall descriptive totals. **Conclusion:** The tabulations shows a possible association between maternal anemia and low birth weight or preterm birth, but they do not constitute verified evidence from a Sudanese prospective cohort. Clinical interpretation and journal submission as original research require confirmation of patient-level data, ethics approval, recruitment details, and appropriate adjusted analyses.

**Key Words:** Maternal Anemia, Pregnancy, Low Birth Weight, Preterm Birth, Neonatal Outcomes

## INTRODUCTION

Anemia, especially maternal anemia, is a significant public health problem, particularly in low- and middle-income countries where maternal nutritional deficiencies and lack of proper antenatal care, as well as socioeconomic disadvantage, are contributing factors to the high prevalence of maternal anemia [1]. Anemia in pregnancy is defined by a decrease in hemoglobin and could affect the ability of maternal and fetal tissues to receive oxygen. The World Health Organization (WHO) reported that in the year 2023, about 35.5% of pregnant women worldwide suffered from anemia, meanwhile, estimates in Pakistan showed that 39.1% of pregnant women were affected by anemia [2]. Folate and vitamin B12 deficiencies, infections, inflammatory diseases, and inherited hemoglobin disorders can also play a role in the development of anemia during pregnancy, but iron deficiency is a leading factor. The high prevalence of maternal anemia emphasizes the need to understand its potential consequences to maternal and neonatal health [3]. The maternal blood volume is increased during pregnancy, along with the nutritional demands, which impose a burden on hematopoiesis. The World Health Organization (WHO) considers hemoglobin levels under 11.0 g/dL in the first and third trimesters, and under 10.5 g/dL in the second trimester, to be anemia. The effects of maternal anemia on the fetus may include decreased availability of oxygen, impaired placental function and associated nutritional deficiencies [4]. These changes can help lead to low birth weight, premature birth, fetal growth restriction and high neonatal morbidity. Low birth weight (defined as birth weight below 2500 g) and preterm birth (defined as delivery before 37 completed weeks of gestation) are important measures of neonatal health and are correlated with respiratory morbidity and mortality, infections, feeding problems, and neonatal death [5]. There have been several studies which have shown that maternal anemia is associated with adverse pregnancy outcomes. In a systematic review and meta-analysis of 148 studies, Young et al. found low maternal hemoglobin concentration was linked to a higher risk of LBW (OR 1.28, 95% CI 1.22–1.35) and preterm

delivery (OR 1.35, 95% CI 1.29–1.42). Additionally, small-for-gestational age (SGA), stillbirth and infant death (neonatal mortality) were associated with the study [6]. Results indicate that HbC may be a useful indicator of risk for the neonate, although this relationship is not necessarily strong depending on the timing and severity of anemia [7]. These relationships may be modified by maternal nutritional status, age at time of assessment for anemia, preexisting medical conditions, and availability of antenatal care. This means that the results of research in one population may not be applicable to other populations, especially in local healthcare contexts. Anemia in pregnant women is a major public health problem of the world especially in low-income areas. In 2023, the World Health Organization (WHO) estimated that an estimated 35.5% of all women worldwide had been affected by anemia during their pregnancy [1,8].

Original hospital-based studies have reported high levels of anaemia in Sudan, with significant variation. Adam and Elmugabil conducted a cross sectional study of 208 pregnant women at the Rabak Maternity Hospital in White Nile State and found that 42.3% of them were anemic of which 1.9% had severe anemia [9]. In the same way, a research carried out in Khartoum city among 180 pregnant ladies found anaemia in 65.0% of women [3]. Also, in Sudanese populations the negative effects of maternal anemia on the neonatal outcome have been reported. A study involving 253 mother–newborn pairs in White Nile State showed that 15.8% of the newborn infants had low birth weight and maternal anemia is significantly associated with low birth weight [10-11]. Based on these findings, maternal anemia is an important indicator to assess in Sudanese health care settings as it has a correlation with adverse neonatal outcome especially low birth weight and pre-term delivery. The present study aims to evaluate the relationship between maternal anemia in pregnancy and poor birth outcomes, such as low birth weight and preterm delivery.

## METHODS

### Study Status and Setting

The supplied manuscript describes a prospective hospital-based cohort in Sudan of pregnant women aged 18–45 years with singleton pregnancies. Its hospital name, city/state, level of maternity care, recruitment start/end dates, screening log, and source dataset have not been provided for verification. The author must supply these details and confirm that all 215 records represent actual recruited women before the study can be reported as an empirical cohort.

### Sample Size

The stated prevalence-based calculation used $p = 0.423$, $Z = 1.96$ and $d = 0.07$: $n=Z^2p(1-p)/d^2 = 191.4$, rounded upward to 192. Inflation by 10% anticipated attrition gives $192/(1-0.10) = 213.3$, rounded to 214, the manuscript target of 215 therefore requires an explicit author explanation of the final upward rounding. This calculation estimates prevalence precision, not statistical power for low birth weight or preterm birth comparisons.

### Recruitment

The original text describes consecutive non-probability enrollment, but the personnel, dates, number screened, eligible, excluded, enrolled, lost, and analyzed require confirmation from the recruitment log.

### Inclusion Criteria

It involved women who were pregnant between 18-45 years, and had their pregnancies confirmed by the selected hospital during their antenatal care. Participants had hemoglobin levels recorded while they were pregnant, and accurate information about gestational age.

### Exclusion Criteria

Multiple pregnancies, inherited hemoglobin disorders (like sickle cell disease and thalassemia), and major chronic diseases that had adverse effects on hemoglobin concentration or fetal growth (like advanced chronic kidney disease) were excluded. Major fetal anomalies and pregnancies with unreliable gestational age determination were also not included.

### Data Collection Procedure

The original report describes collection of demographic, obstetric, antenatal, supplementation, and laboratory information, with follow-up to delivery. It states that hemoglobin was obtained from antenatal laboratory records or routine testing, with measurement in the first (48), second (113), or third (54) trimester. The exact trimester-specific anemia and severity thresholds, guideline version, handling of repeated hemoglobin values, altitude adjustments, and gestational-age adjustment in analyses were not specified and require verification against the protocol. Hemoglobin alone cannot determine iron-deficiency or other anemia etiology. Information on ferritin, iron studies, folate/B12, infection, treatment initiation, adherence, and changes during follow-up is unavailable in the supplied material. Low birth weight was defined as <2500 g and preterm birth as <37 completed weeks, the manuscript states birth weight was obtained on a calibrated scale preferably within one hour, but calibration records, measurer, gestational-dating hierarchy, and handling of uncertain dates are unverified. The source describes written consent but provides no ethics committee name, approval date/number, or record-access permissions. These details must be documented, not assumed. The primary outcomes described were low birth weight and preterm birth, NICU admission and neonatal mortality were listed as descriptive additional outcomes without exposure-stratified data or ascertainment definitions.

### Data Analysis

The source report states that SPSS version 26 was used and that chi-square or Fisher exact tests were considered for categorical comparisons, with two-sided significance threshold $p<0.05$ not explicitly confirmed. The supplied aggregate counts permit crude risk ratios and absolute risk differences, but not confounder-adjusted estimates. No participant-level dataset, model diagnostics, missing-data

accounting, or multiple-testing plan was supplied. Consequently, no multivariable regression or severity trend test has been claimed in this revision. Appropriate analysis of authentic records should consider maternal age, BMI, parity, education, antenatal visits, supplementation, hypertension, gestational diabetes, and gestational age at hemoglobin measurement, robust Poisson regression may estimate adjusted risk ratios where suitable. All inferential claims remain provisional pending data authentication.

## RESLTS

The supplied, unverified tabulation includes 215 women with mean age 27.8±5.9 years and BMI 25.4±4.3 kg/m². Overall baseline values are displayed in Table 1. Exposure-specific baseline characteristics were not supplied, the requested anemic versus non-anemic baseline comparison cannot be reconstructed from aggregate totals and must be generated from authentic participant records.The supplied summary records mean hemoglobin 10.9±1.5 g/dL, 91/215 (42.3%) classified as anemic, and 124/215 (57.7%) as non-anemic. Among those classified as anemic, the reported counts are mild 53, moderate 32, and severe 6. Because the severity cutoffs and original measurements are unavailable, these categories are unverified and cannot support a clinical severity gradient. Trimester counts are first 48, second 113, and third 54 (Table 2).

In the unverified aggregate tabulation, mean gestational age at delivery was 37.8±2.1 weeks and mean birth weight

Table 1: Baseline Demographic and Obstetric Characteristics (N = 215)

| Variable | Mean±SD / n (%) |
|---|---|
| Maternal age (years) | 27.8±5.9 |
| BMI (kg/m²) | 25.4±4.3 |
| Gestational age at enrollment (weeks) | 21.6±5.8 |
| Gravidity | 2.9±1.5 |
| Parity | 1.7±1.3 |
| Residence | |
| Urban | 128 (59.5) |
| Rural | 87 (40.5) |
| Educational status | |
| No formal education | 42 (19.5) |
| Primary education | 58 (27.0) |
| Secondary education | 79 (36.7) |
| Higher education | 36 (16.7) |
| Antenatal care visits | |
| Fewer than 4 | 93 (43.3) |
| 4 or more | 122 (56.7) |
| Iron and folic acid supplementation | 146 (67.9) |
| Hypertension during pregnancy | 24 (11.2) |
| Gestational diabetes mellitus | 18 (8.4) |

Table 2: Maternal Hemoglobin and Anemia Characteristics (n = 215)

| Variable | Mean±SD / n (%) |
|---|---|
| Maternal hemoglobin (g/dL) | 10.9±1.5 |
| Anemia status | |
| Anemic | 91 (42.3) |
| Non-anemic | 124 (57.7) |
| Anemia severity among anemic women (n = 91) | |
| Mild anemia | 53 (58.2) |
| Moderate anemia | 32 (35.2) |
| Severe anemia | 6 (6.6) |
| Trimester of hemoglobin assessment | |
| First trimester | 48 (22.3) |
| Second trimester | 113 (52.6) |
| Third trimester | 54 (25.1) |

Table 3: Neonatal Outcomes (n = 215)

| Neonatal outcome | Mean±SD / n (%) |
|---|---|
| Gestational age at delivery (weeks) | 37.8±2.1 |
| Neonatal birth weight (g) | 2865±520 |
| Birth weight category | |
| Low birth weight (<2500 g) | 35 (16.3) |
| Birth weight ≥2500 g | 180 (83.7) |
| Gestational age category | |
| Preterm delivery (<37 weeks) | 36 (16.7) |
| Delivery ≥37 weeks | 179 (83.3) |
| NICU admission | 29 (13.5) |
| Neonatal mortality | 5 (2.3) |

Table 4: Maternal Anemia and Adverse Neonatal Outcomes (n = 215)

| Outcome | Anemic (n = 91), n (%) | Non-anemic (n = 124), n (%) | RR (95% CI) | p-value | RD (percentage ints) |
|---|---|---|---|---|---|
| Low birth weight | | | | | |
| Yes | 23 (25.3) | 12 (9.7) | 2.61 (1.37–4.97) | 0.002 | +15.6 |
| No | 68 (74.7) | 112 (90.3) | Reference | — | — |
| Preterm delivery | | | | | |
| Yes | 22 (24.2) | 14 (11.3) | 2.14 (1.16–3.95) | 0.012 | +12.9 |
| No | 69 (75.8) | 110 (88.7) | Reference | — | — |

RR = crude risk ratio, CI = confidence interval, RD = absolute risk difference. All counts and inferential statistics require verification against authentic source records. No adjustment for confounding or multiple comparisons was available

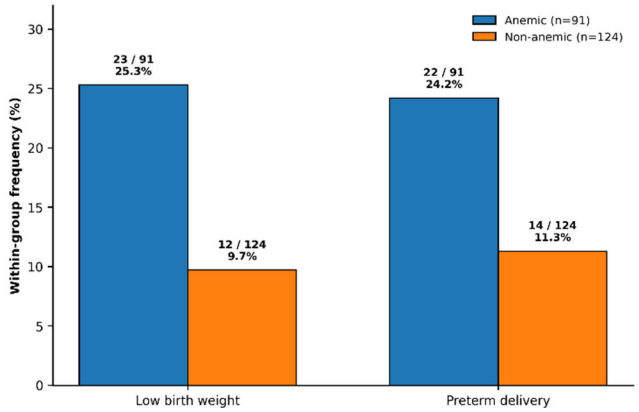



Figure 1: Neonatal Outcomes by Maternal Anemia Status

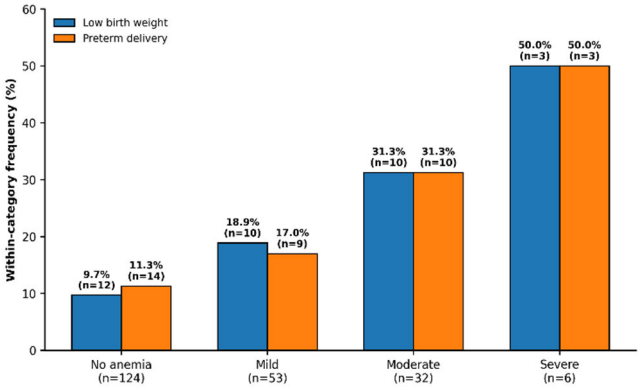



Figure 2: Adverse Neonatal Outcomes by Anemia Severity

2865±520 g. Low birth weight was recorded in 35/215 (16.3%) and preterm birth in 36/215 (16.7%). The source additionally lists 29 NICU admissions (13.5%) and 5 neonatal deaths (2.3%), but provides neither anemia-stratified counts nor definitions of NICU admission or the mortality observation period. These are therefore descriptive counts only, not analyzed outcomes (Table 3).

The supplied aggregate counts show low birth weight in 23/91 (25.3%) of the anemic category versus 12/124 (9.7%) of the non-anemic category, with crude RR 2.61 and absolute risk difference 15.6 percentage points. Preterm birth occurred in 22/91 (24.2%) versus 14/124 (11.3%), with crude RR 2.14 and absolute risk difference 12.9 percentage points. These are unadjusted calculations from unverified counts, subject to confounding and potential dataset construction (Table 4 Figure 1-2).

## DISCUSSION

The source document explicitly states that anemia-severity proportions were selected to represent a clinically feasible distribution rather than an observed recruited population. It also describes a simulated group and an example dataset. These statements preclude treating the numerical results as verified observations from 215 Sudanese patients. The tables and figures are therefore retained solely as clearly labeled, unverified summaries pending the author's provision of an authentic dataset, hospital identification, ethics documentation, and reproducible analysis. Published Sudanese studies may provide background context, but cannot authenticate this manuscript's numbers.

In the aggregate comparison, the crude proportion with low birth weight was 25.3% versus 9.7%, and with preterm birth was 24.2% versus 11.3% for the categories labeled anemic and non-anemic, respectively. These differences should not be interpreted as causal or as clinically observed effect sizes. Maternal age, BMI, parity, education, access to antenatal care, supplementation, comorbidities, gestational timing of hemoglobin measurement, and anemia treatment may confound such comparisons. A patient-level adjusted analysis is necessary if authentic data exist.

The severity categories contain only six women classified as severely anemic, with three low-birth-weight and three preterm events (50% for each outcome). With a denominator of six, these percentages are imprecise and cannot establish a dose-response trend. The reported mild and moderate categories likewise require confirmation of hemoglobin thresholds and source records. Birth weight is affected by gestational age; low birth weight alone should not be equated with fetal growth restriction. Spontaneous versus medically indicated preterm birth and small-for-gestational-age status were not available.

### Limitations and Data-Integrity Requirements

The principal limitation is unresolved data provenance: the source text identifies constructed values, and no authentic patient-level file or ethics documentation was supplied. Further limitations include unspecified hospital and recruitment dates, unavailable screening and attrition counts, absence of anemia-stratified baseline characteristics, lack of adjusted analyses, missing hemoglobin severity thresholds and treatment histories, varying gestational age at exposure measurement, and uncertain ascertainment of NICU admission and neonatal death. The severe-anemia subgroup is too small for reliable inference. These issues cannot be remedied by language editing alone.

## CONCLUSIONS

The supplied figures cannot support conclusions about actual Sudanese patients until the cohort, ethics approval, original observations, and statistical analyses are verified. If authentic clinical data are available, the manuscript should be reanalyzed and rewritten to report adjusted associations and appropriately qualified conclusions.

## Acknowledgement

Author would like to thank the Deanship of Scientific Research at Prince Sattam Bin Abdulaziz University for supporting this research.

## REFERENCES

[1] United Nations. "Sustainable Development Goals." *United Nations*, https://sdgs.un.org/goals/goal3#targets_and_indicators. Accessed 30 Mar. 2025.

[2] United Nations Inter-Agency Group for Child Mortality Estimation (UN IGME), UNICEF, and World Health Organization. *Levels & Trends in Child Mortality: Report 2023*. 2023.

[3] Elmugabil, A. *et al.* "Prevalence of Low Birth Weight and Its Association with Anemia in White Nile State, Sudan: A Cross-Sectional Study." *SAGE Open Nursing*, vol. 9, 2023, article 23779608231197590. https://doi.org/10.1177/23779608231197590.

[4] Elmugabil, A. *et al.* "Evaluation of the Association between Haemoglobin Levels and Preterm Birth at Khartoum, Sudan: A Hospital-Based Study." *Frontiers in Nutrition*, vol. 9, 2022, article 933557. https://doi.org/10.3389/fnut.2022.933557.

[5] Khezri, R. *et al.* "Association between Maternal Anemia during Pregnancy with Low Birth Weight Their Infants." *Scientific Reports*, vol. 15, no. 1, 2025, article 6446. https://doi.org/10.1038/s41598-025-91316-1.

[6] Aziz, A. *et al.* "Adverse Perinatal Outcomes: Their Association with Maternal Anemia." *Pakistan Journal of Health Sciences*, vol. 6, no. 1, 2025, pp. 107–111. https://doi.org/10.54393/pjhs.v6i1.2109.

[7] Haggaz, A. D. *et al.* "Anaemia and Low Birthweight in Western Sudan." *Transactions of the Royal Society of Tropical Medicine and Hygiene*, vol. 104, no. 3, 2010, pp. 234–236. https://doi.org/10.1016/j.trstmh.2009.07.013.

[8] Beressa, G. *et al.* "Association between Anemia in Pregnancy with Low Birth Weight and Preterm Birth in Ethiopia: A Systematic Review and Meta-Analysis." *PLOS ONE*, vol. 19, no. 9, 2024, article e0310329. https://doi.org/10.1371/journal.pone.0310329.

[9] Parks, S. *et al.* "Maternal Anaemia and Maternal, Fetal, and Neonatal Outcomes in a Prospective Cohort Study in India and Pakistan." *BJOG: An International Journal of Obstetrics & Gynaecology*, vol. 126, no. 6, 2019, pp. 737–743. https://doi.org/10.1111/1471-0528.15585.

[10] Zhou, L. M. *et al.* "Relation of Hemoglobin Measured at Different Times in Pregnancy to Preterm Birth and Low Birth Weight in Shanghai, China." *American Journal of Epidemiology*, vol. 148, no. 10, 1998, pp. 998–1006. https://doi.org/10.1093/oxfordjournals.aje.a009577.

[11] Yi, S. W. *et al.* "Anemia before Pregnancy and Risk of Preterm Birth, Low Birth Weight and Small-for-Gestational-Age Birth in Korean Women." *European Journal of Clinical Nutrition*, vol. 67, no. 4, 2013, pp. 337–342. https://doi.org/10.1038/ejcn.2013.12.