

# Prevalence of Postpartum Anemia and Associated Risk Factors in Najran Hospitals, Saudi Arabia; A Retrospective Observational Study

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**Introduction:** Postpartum anemia (PPA) occurs when hemoglobin (Hb) levels drop below 11 g/dl within 42 days after childbirth. This growing public health issue is a leading cause of complications that can affect maternal health and increase the risk of morbidity and mortality. However, evidence about its prevalence and associated risk factors is still unclear.

**Purpose:** This study aimed to determine the incidence of PPA, potential risk factors associated with its occurrence, and severity in two major hospitals in Najran, Saudi Arabia.

**Patients and Methods:** A retrospective observational study was performed among postpartum women admitted to the Maternity and Children Hospital and the Obstetrics and Gynecology Clinic at the Najran University Hospital. The data was collected from electronic medical records from November 2023 to March 2024, including the patient's characteristics, like nationality, body mass index (BMI), education level, employment status, medical history, delivery details, laboratory results, and anemia diagnosis. Statistical analysis was conducted using IBM SPSS software, with significance defined as p-values below 0.05.

**Results:** A total of 565 postpartum women were included. The prevalence of PPA was 52.7%. Anemic participants prior to labor were significantly 4.986 times more likely to experience postpartum anemia compared to non-anemic participants, with a 95% confidence interval of (1.842–13.496) and a p-value of 0.002. The risk factors regarding the severity of anemia were significantly high among participants with childbirth complications (79.2%), one parity (67.2%), and prepartum anemia (72.6%).

**Conclusion:** This study highlights a significant prevalence of postpartum anemia among women, strongly linked to anemia prior to labor. The severity of postpartum anemia is particularly greater in women with childbirth complications, those who have had one previous birth, or who were anemic before delivery. Comprehensive postpartum follow-up for changes to improve access to prenatal and postnatal care are essential strategies to reduce postpartum anemia and enhance maternal health outcomes.

**Keywords:** postpartum anemia, antenatal anemia, maternal health, postpartum hemorrhage

## Introduction

Anemia is a worldwide public health issue affecting both industrialized and developing nations, linked to detrimental impacts on social and economic growth as well as population health.<sup>1</sup> Anemia affects 56 million and 38% of pregnant women.<sup>2,3</sup> There are well-established studies on anemia in pregnant women. Recently, the scope and impact of postpartum anemia (PPA) have become an interesting area of study. The duration of the postpartum phase spans from the delivery of the fetus to 42 days. It is the most critical period for maternal and neonatal health and survival. PPA (hemoglobin [Hb] level below 11g/dl) is a public health issue worldwide, with a higher prevalence in developing

countries, reaching 80%.<sup>4</sup> In Saudi Arabia, specific data on PPA is limited, but general anemia prevalence among pregnant women ranges from 27.3% to 39%, with 21% experiencing moderate anemia.<sup>5</sup>

PPA is one of the most common puerperal complications and the major cause of maternal morbidity and mortality.<sup>6</sup> The risk factors for PPA identified in published research include antenatal iron deficiency, active bleeding during delivery, infections, hemoglobinopathies, and nutritional deficiencies.<sup>7</sup> Postpartum hemorrhage (PPH) and prepartum anemia account for 5% to 25% of PPA causes. Additionally, poor socioeconomic status, in terms of income, parity, educational level, age, antenatal care, and birth spacing, plays a crucial role as a risk factor for PPA.<sup>8</sup>

If left unaddressed, PPA can lead to postpartum morbidity and mortality by 20–40%. One of its life-threatening complications is PPH. Although it is unusual in Saudi Arabia, there is a moderate association between anemia during pregnancy and PPH.<sup>9</sup> Other complications include preeclampsia, cardiac failure, antepartum hemorrhage, and puerperal sepsis. Also, it contributes to an increased percentage of infant mortality due to low birth weight, especially in developing countries.<sup>10</sup>

To date, only a limited number of studies on PPA and its risk factors among women in Saudi Arabia have been conducted, highlighting a research gap. Understanding the risk factors associated with PPA may enhance the development of screening programs and facilitate early interventions to reduce anemia and its complications. This study aimed to determine the prevalence and risk factors of PPA among women attending different major hospitals in Najran, Saudi Arabia.

## Materials and Methods

### Study Design and Duration

This retrospective observational study was conducted among postpartum women admitted for delivery to the Maternity and Children Hospital and the Obstetrics and Gynecology Clinic at the Najran University Hospital, a military and private hospital. The data was collected from electronic medical records from November 2023 to March 2024.

### Study Population

The study included postpartum women with available Hb levels or diagnosed with PPA.

### Sample Size

All women were admitted to the Maternity and Children Hospital and the Obstetrics and Gynecology Clinic at the Najran University Hospital, a military and private hospital with available Hb levels, or diagnosed with PPA within the study period.

### Data Collection

Data was extracted from electronic medical records, including the patient's characteristics, such as nationality, body mass index (BMI), education level, and employment status. Their medical history, delivery details, laboratory results, and anemia diagnosis were also collected.

### Data Entry and Analysis

The data was obtained and revised in an Excel sheet. Statistical analysis was conducted using the IBM SPSS computer program (version 26.0, Armonk, NY, USA). Categorical variables were expressed in percentages and numbers. The Chi-square test and Fisher's Exact Test were used to compare different categorical variables. A binary logistic regression model was used to examine the association between independent variables and the PPA. The statistical significance was considered when p-values were below 0.05.

### Ethical Considerations

Ethical approval for the study was obtained from the research and ethical committee of Najran Health Cluster IRB (2024–05E) on June 05, 2024, ensuring compliance with ethical guidelines and standards for human research. Measures were taken to safeguard the privacy and confidentiality of participants' data throughout the study duration. Patient data confidentiality was maintained throughout the study, complying with the Declaration of Helsinki. All patient information was anonymized and securely stored to prevent unauthorized access. The patient consent to review their medical records

was not required by the Ethical Committee of Najran Health Cluster because the type of study was retrospective and not direct contact to patient only review the medical record with kept confidentiality of participant data.

## Results

Five hundred sixty-five postpartum women were included in the study. Most were Saudis (67.4%) and delivered at full term (91.5%). About one-third of the women used iron supplementation tablets (29%), and 2.3% received injections (Table 1).

The prevalence of PPA was 52.7%, with 55.4% of the anemic women having moderate anemia. (Table 2).

**Table 1** Demographic Characteristics and Obstetric History of Postpartum Women (N=565)

| Parameters                                | Category                       | Number | Percentage |
|-------------------------------------------|--------------------------------|--------|------------|
| <b>Nationality</b>                        | Saudi                          | 381    | 67.4       |
|                                           | Non-Saudi                      | 184    | 32.6       |
| <b>BMI (Kg/m<sup>2</sup>)<br/>(N=555)</b> | < 25 (Normal)                  | 110    | 19.8       |
|                                           | 25 to < 30 (Overweight)        | 193    | 34.8       |
|                                           | ≥ 30 (Obese)                   | 252    | 45.4       |
| <b>Education level<br/>(N=312)</b>        | Primary and secondary degree   | 245    | 78.5       |
|                                           | University degree              | 67     | 21.5       |
| <b>Employment status</b>                  | Employed                       | 17     | 3.0        |
|                                           | Unemployed                     | 548    | 97.0       |
| <b>Number of visits during pregnancy</b>  | <3                             | 237    | 41.9       |
|                                           | ≥ 3                            | 328    | 58.1       |
| <b>History of miscarriage</b>             | Yes                            | 187    | 33.1       |
|                                           | No                             | 378    | 66.9       |
| <b>If yes, please specify<br/>(N=150)</b> | One                            | 87     | 58.0       |
|                                           | Two                            | 37     | 24.7       |
|                                           | Three                          | 19     | 12.7       |
|                                           | Four                           | 6      | 4.0        |
|                                           | Nine                           | 1      | 0.7        |
| <b>Mode of birth</b>                      | Caesarian birth                | 187    | 33.1       |
|                                           | Vaginal birth                  | 378    | 66.9       |
| <b>Childbirth complications</b>           | Yes                            | 43     | 7.6        |
|                                           | No                             | 552    | 92.4       |
| <b>Medications to induce labor</b>        | Yes                            | 76     | 13.5       |
|                                           | No                             | 489    | 86.5       |
| <b>Birth weight</b>                       | <2500 gm (low birth weight)    | 58     | 10.3       |
|                                           | ≥2500 gm (Normal birth weight) | 507    | 89.7       |

(Continued)

**Table 1** (Continued).

| Parameters                        | Category           | Number | Percentage |
|-----------------------------------|--------------------|--------|------------|
| <b>Parity</b>                     | I                  | 131    | 23.2       |
|                                   | >I                 | 434    | 76.8       |
| <b>Pregnancy duration</b>         | Premature (<37)    | 26     | 4.6        |
|                                   | Term (37–41)       | 517    | 91.5       |
|                                   | Post-term (>41)    | 22     | 3.9        |
| <b>Iron supplementation usage</b> | Tablet             | 164    | 29.0       |
|                                   | Injection          | 13     | 2.3        |
|                                   | No supplementation | 388    | 68.7       |

**Table 2** Clinical Characteristics and Anemia Diagnosis of Postpartum Women (N=565)

| Parameters                           | Category                              | Number | Percentage |
|--------------------------------------|---------------------------------------|--------|------------|
| <b>Any medical disease</b>           | Yes                                   | 72     | 12.7       |
|                                      | No                                    | 493    | 87.3       |
| <b>If yes, please specify (N=49)</b> | Hypothyroidism                        | 14     | 28.6       |
|                                      | Gestational diabetes mellitus         | 7      | 14.3       |
|                                      | Asthma                                | 6      | 12.2       |
|                                      | Diabetes mellitus                     | 6      | 12.2       |
|                                      | Hypertension                          | 5      | 10.2       |
|                                      | Epilepsy                              | 2      | 4.1        |
|                                      | Anemia                                | 2      | 4.1        |
|                                      | Pregnancy-induced hypertension        | 2      | 4.1        |
|                                      | Chronic renal failure                 | 1      | 2.0        |
|                                      | Depression                            | 1      | 2.0        |
|                                      | Drugs allergy                         | 1      | 2.0        |
|                                      | Hepatitis B                           | 1      | 2.0        |
|                                      | Hemorrhoids                           | 1      | 2.0        |
|                                      | Varicose veins in the left lower limb | 1      | 2.0        |
|                                      | Pemphigoid gestation                  | 1      | 2.0        |
|                                      | Preeclampsia                          | 1      | 2.0        |
|                                      | Sickle cell disease                   | 1      | 2.0        |
|                                      | Ventricular tachycardia on metoprolol | 1      | 2.0        |

(Continued)

**Table 2** (Continued).

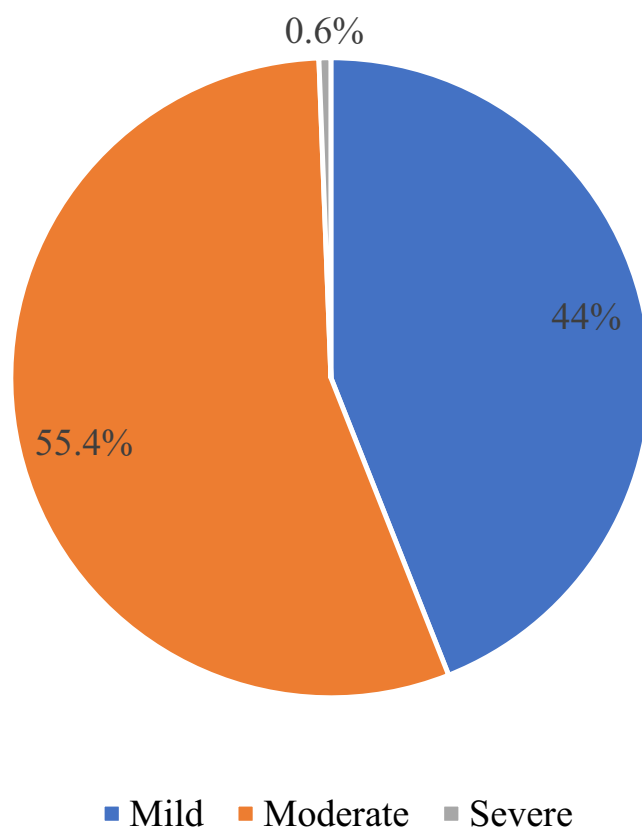
| Parameters                                                         | Category                  | Number | Percentage |
|--------------------------------------------------------------------|---------------------------|--------|------------|
| <b>Laboratory anemia before labor (WHO classification) (N=563)</b> | Anemic (Hb < 11 g/dl)     | 234    | 41.6       |
|                                                                    | Non-anemic (Hb ≥ 11 g/dl) | 329    | 58.4       |
| <b>Serum ferritin before labor (N=142)</b>                         | Normal                    | 95     | 66.9       |
|                                                                    | Abnormal                  | 47     | 33.1       |
| <b>Serum iron before labor (N=138)</b>                             | Normal                    | 94     | 68.1       |
|                                                                    | Abnormal                  | 44     | 31.9       |
| <b>Serum total iron-binding capacity before labor (N=140)</b>      | Normal                    | 95     | 67.9       |
|                                                                    | Abnormal                  | 45     | 32.1       |
| <b>Blood transfusion before labor</b>                              | Yes                       | 23     | 4.1        |
|                                                                    | No                        | 542    | 95.9       |
| <b>Postpartum hemorrhage (PPH)</b>                                 | Yes                       | 55     | 9.7        |
|                                                                    | No                        | 510    | 90.3       |
| <b>Blood loss (mL)</b>                                             | ≤250                      | 393    | 69.6       |
|                                                                    | 251–500                   | 139    | 24.6       |
|                                                                    | 501–1000                  | 30     | 5.3        |
|                                                                    | >1000                     | 3      | 0.5        |
| <b>Laboratory anemia after labor (WHO classification)</b>          | Anemic (Hb < 11 g/dl)     | 298    | 52.7       |
|                                                                    | Non-anemic (Hb ≥ 11 g/dl) | 267    | 47.3       |
| <b>Anemia severity (N=298)</b>                                     | Mild                      | 131    | 44         |
|                                                                    | Moderate                  | 165    | 55.4       |
|                                                                    | Severe                    | 2      | 0.6        |
| <b>Blood transfusion postpartum</b>                                | Yes                       | 32     | 5.7        |
|                                                                    | No                        | 533    | 94.3       |

Figure 1 illustrates the anemia severity of anemia among postpartum women. 44% had mild anemia, 55.4% had moderate anemia, and only 0.6% had severe anemia.

There was no significant association between the occurrence of anemia regarding the socio-demographic characteristics and obstetric history (Table 3).

Table 4 illustrates the risk factors of having PPA anemia. Being anemic was significantly more common among participants having anemia before labor than others (85.9% vs 29.2%), abnormal serum ferritin before labor than others (83% vs 40%), abnormal serum iron before labor than others (84.1% vs 40.4%) and abnormal serum total iron-binding capacity before labor than others (82.2% vs 41.1%) ( $p < 0.001$ ).

Table 5 shows the logistic regression analysis of the occurrence of PPA. Anemic participants prior to labor were significantly 4.986 times more likely to experience postpartum anemia compared to non-anemic participants, with a 95% confidence interval of (1.842–13.496) and a p-value of 0.002.



**Figure 1** Anemia severity of postpartum women.

Moderate to severe anemia was significantly more common among participants with childbirth complications than others (79.2% vs 54.0%,  $p=0.017$ ). Additionally, Moderate to severe anemia was significantly more common among participants with one parity than others (67.2% vs 53.0%,  $p=0.043$ ) (Table 6).

**Table 3** Association Between the Occurrence of Anemia Regarding the Socio-Demographic Characteristics and Obstetric History

| Parameters               | Category                      | Occurrence of Anemia N (%) |            | P-value |
|--------------------------|-------------------------------|----------------------------|------------|---------|
|                          |                               | Anemic                     | Non-anemic |         |
| Nationality              | Saudi                         | 201 (52.8)                 | 180 (47.2) | 0.993   |
|                          | Non-Saudi                     | 97 (52.7)                  | 87 (47.3)  |         |
| BMI (Kg/m <sup>2</sup> ) | Normal                        | 58 (52.7)                  | 52 (47.3)  | 0.782   |
|                          | Overweight                    | 97 (50.3)                  | 96 (49.7)  |         |
|                          | Obese                         | 135 (53.6)                 | 117 (46.4) |         |
| Education level          | Less than a university degree | 132 (53.9)                 | 113 (46.1) | 0.286   |
|                          | University degree             | 41 (61.2)                  | 26 (38.8)  |         |
| Employment status        | Employed                      | 10 (58.8)                  | 7 (41.2)   | 0.610   |
|                          | Unemployed                    | 288 (52.6)                 | 260 (47.4) |         |

(Continued)

Table 3 (Continued).

| Parameters                        | Category                    | Occurrence of Anemia N (%) |            | P-value |
|-----------------------------------|-----------------------------|----------------------------|------------|---------|
|                                   |                             | Anemic                     | Non-anemic |         |
| Any medical disease               | Yes                         | 36 (50)                    | 36 (50)    | 0.618   |
|                                   | No                          | 262 (53.1)                 | 231 (46.9) |         |
| Number of visits during pregnancy | Less than three             | 129 (54.4)                 | 108 (45.6) | 0.495   |
|                                   | More than or equal to three | 169 (51.5)                 | 159 (48.5) |         |
| History of miscarriage            | Yes                         | 94 (50.3)                  | 93 (49.7)  | 0.407   |
|                                   | No                          | 204 (54.0)                 | 174 (46)   |         |
| Mode of birth                     | Caesarian birth             | 109 (58.3)                 | 78 (41.7)  | 0.063   |
|                                   | Vaginal birth               | 189 (50)                   | 189 (50)   |         |
| Childbirth complications          | Yes                         | 24 (55.8)                  | 19 (44.2)  | 0.675   |
|                                   | No                          | 274 (52.5)                 | 248 (47.5) |         |
| Medications to induce labor       | Yes                         | 45 (59.2)                  | 31 (40.8)  | 0.225   |
|                                   | No                          | 253 (51.7)                 | 236 (48.3) |         |
| Birth weight                      | <2500 gm (low birth weight) | 34 (58.6)                  | 24 (41.4)  | 0.344   |
|                                   | ≥ 2500 gm (Normal)          | 264 (52.1)                 | 243 (47.9) |         |
| Parity                            | >I                          | 234 (53.9)                 | 200 (46.1) | 0.309   |
|                                   | I                           | 64 (48.9)                  | 67 (51.1)  |         |
| Pregnancy duration                | Premature (<37)             | 14 (53.8)                  | 12 (46.2)  | 0.978   |
|                                   | Term (37–41)                | 272 (52.6)                 | 245 (47.4) |         |
|                                   | Post-term (>41)             | 12 (54.5)                  | 10 (45.5)  |         |

Table 4 Risk Factors Associated with the Occurrence of PPA

| Parameters                     | Category   | Occurrence of Anemia N (%) |            | P-value |
|--------------------------------|------------|----------------------------|------------|---------|
|                                |            | Anemic                     | Non-anemic |         |
| Any medical disease            | Yes        | 36 (50)                    | 36 (50)    | 0.618   |
|                                | No         | 262 (53.1)                 | 231 (46.9) |         |
| Laboratory anemia before labor | Anemic     | 201 (85.9)                 | 33 (14.1)  | <0.001  |
|                                | Non-anemic | 96 (29.2)                  | 233 (70.8) |         |
| Serum ferritin before labor    | Normal     | 38 (40)                    | 57 (60)    | <0.001  |
|                                | Abnormal   | 39 (83)                    | 8 (17)     |         |
| Serum iron before labor        | Normal     | 38 (40.4)                  | 56 (59.6)  | <0.001  |
|                                | Abnormal   | 37 (84.1)                  | 7 (15.9)   |         |

(Continued)

**Table 4** (Continued).

| Parameters                                            | Category      | Occurrence of Anemia N (%) |            | P-value          |
|-------------------------------------------------------|---------------|----------------------------|------------|------------------|
|                                                       |               | Anemic                     | Non-anemic |                  |
| <b>Serum total iron-binding capacity before labor</b> | Normal        | 39 (41.1)                  | 56 (58.9)  | <b>&lt;0.001</b> |
|                                                       | Abnormal      | 37 (82.2)                  | 8 (17.8)   |                  |
| <b>Blood transfusion before labor</b>                 | Yes           | 21 (91.3)                  | 2 (8.7)    | <b>&lt;0.001</b> |
|                                                       | No            | 277 (51.1)                 | 265 (48.9) |                  |
| <b>Postpartum hemorrhage</b>                          | Yes           | 31 (56.4)                  | 24 (43.6)  | 0.571            |
|                                                       | No            | 267 (52.4)                 | 243 (47.6) |                  |
| <b>Blood loss (mL)</b>                                | ≤250          | 196 (49.9)                 | 197 (50.1) | <b>0.001</b>     |
|                                                       | 251–500       | 76 (53.5)                  | 66 (46.5)  |                  |
|                                                       | More than 500 | 26 (86.7)                  | 4 (13.3)   |                  |
| <b>Blood transfusion postpartum</b>                   | Yes           | 27 (84.4)                  | 5 (15.6)   | <b>&lt;0.001</b> |
|                                                       | No            | 271 (50.8)                 | 262 (49.2) |                  |

**Note:** A bolded p-value indicates statistical significance.

Regarding the severity of anemia, moderate to severe anemia was significantly more common among participants having anemia before labor than those others (72.6% vs 20.8%,  $p<0.001$ ) and among participants with abnormal serum iron before labor than others (64.9% vs 42.1%,  $p=0.048$ ). Moderate to severe anemia was also significantly more common among those who needed blood transfusions before labor than others (85.7% vs 53.8%,  $p=0.004$ ) (Table 7).

**Table 5** Logistic Regression for the Occurrence of PPA

| Categories                                                          | Odds Ratio | Confidence Interval (95%) | P-value      |
|---------------------------------------------------------------------|------------|---------------------------|--------------|
| <b>Medical disease (Yes=ref)</b>                                    |            |                           |              |
| No                                                                  | 0.781      | (0.210-2.901)             | 0.712        |
| <b>Laboratory anemia before labor (Non-anemic)</b>                  |            |                           |              |
| Anemic                                                              | 4.986      | (1.842-13.496)            | <b>0.002</b> |
| <b>Serum ferritin before labor (Normal)</b>                         |            |                           |              |
| Abnormal                                                            | 2.611      | (0.104-65.381)            | 0.559        |
| <b>Serum iron before labor (Normal= ref)</b>                        |            |                           |              |
| Abnormal                                                            | 1.831      | (0.072-46.806)            | 0.715        |
| <b>Serum total iron-binding capacity before labor (Normal= ref)</b> |            |                           |              |
| Abnormal                                                            | 0.730      | (0.045-11.834)            | 0.824        |
| <b>Blood transfusion before labor (Yes=ref)</b>                     |            |                           |              |
| No                                                                  | 0          | (0-0)                     | 0.999        |

(Continued)

**Table 5** (Continued).

| Categories                                    | Odds Ratio | Confidence Interval (95%) | P-value |
|-----------------------------------------------|------------|---------------------------|---------|
| <b>Postpartum hemorrhage</b> (Yes=ref)        |            |                           |         |
| No                                            | 2.394      | (0.117-49.026)            | 0.571   |
| <b>Blood loss (mL)</b> (More than 500=ref)    |            |                           |         |
| ≤250                                          | 1.397      | (0.165-11.809)            | 0.759   |
| 251–500                                       | 1.234      | (0.155-9.806)             | 0.843   |
| <b>Blood transfusion postpartum</b> (Yes=ref) |            |                           |         |
| No                                            | 0          | (0-0)                     | 0.999   |

**Note:** A bolded p-value indicates statistical significance.

**Table 6** Association Between the Anemia Severity Regarding the Socio-Demographic Characteristics and Obstetric History

| Parameters                               | Category                      | Anemia Severity N (%) |                    | P-value      |
|------------------------------------------|-------------------------------|-----------------------|--------------------|--------------|
|                                          |                               | Mild                  | Moderate to Severe |              |
| <b>Nationality</b>                       | Saudi                         | 92 (45.8)             | 109 (54.2)         | 0.364        |
|                                          | Non-Saudi                     | 39 (40.2)             | 58 (59.8)          |              |
| <b>BMI (Kg/m<sup>2</sup>)</b>            | Normal                        | 20 (34.5)             | 38 (65.5)          | 0.215        |
|                                          | Overweight                    | 43 (44.3)             | 54 (55.7)          |              |
|                                          | Obese                         | 65 (48.1)             | 70 (51.9)          |              |
| <b>Education level</b>                   | Less than a university degree | 59 (44.7)             | 73 (55.3)          | 0.215        |
|                                          | University degree             | 23 (56.1)             | 18 (43.9)          |              |
| <b>Employment status</b>                 | Employed                      | 6 (60)                | 4 (40)             | 0.299*       |
|                                          | Unemployed                    | 125 (43.4)            | 163 (56.6)         |              |
| <b>Any medical disease</b>               | Yes                           | 14 (38.9)             | 22 (61.1)          | 0.513        |
|                                          | No                            | 117 (44.7)            | 145 (55.3)         |              |
| <b>Number of visits during pregnancy</b> | Less than three               | 54 (41.9)             | 75 (58.1)          | 0.524        |
|                                          | More than or equal to three   | 77 (45.6)             | 92 (54.4)          |              |
| <b>History of miscarriage</b>            | Yes                           | 48 (51.1)             | 46 (48.9)          | 0.094        |
|                                          | No                            | 83 (40.7)             | 121 (59.3)         |              |
| <b>Mode of birth</b>                     | Caesarian birth               | 47 (43.1)             | 62 (56.9)          | 0.824        |
|                                          | Vaginal birth                 | 84 (44.4)             | 105 (55.6)         |              |
| <b>Childbirth complications</b>          | Yes                           | 5 (20.8)              | 19 (79.2)          | <b>0.017</b> |
|                                          | No                            | 126 (46.0)            | 148 (54.0)         |              |

(Continued)

**Table 6** (Continued).

| Parameters                  | Category                    | Anemia Severity N (%) |                    | P-value      |
|-----------------------------|-----------------------------|-----------------------|--------------------|--------------|
|                             |                             | Mild                  | Moderate to Severe |              |
| Medications to induce labor | Yes                         | 21 (46.7)             | 24 (53.3)          | 0.691        |
|                             | No                          | 110 (43.5)            | 143 (56.5)         |              |
| Birth weight                | <2500 gm (low birth weight) | 11 (32.4)             | 23 (67.6)          | 0.147        |
|                             | ≥ 2500 gm (Normal)          | 120 (45.5)            | 144 (54.5)         |              |
| Parity                      | >1                          | 110 (47.0)            | 124 (53.0)         | <b>0.043</b> |
|                             | 1                           | 21 (32.8)             | 43 (67.2)          |              |
| Pregnancy duration          | Premature (<37)             | 4 (28.6)              | 10 (71.4)          | 0.355        |
|                             | Term (37–41)                | 123 (45.2)            | 149 (54.8)         |              |
|                             | Post-term (>41)             | 4 (33.3)              | 8 (66.7)           |              |

Note: A bolded p-value indicates statistical significance.\*: Fisher's Exact Test.

**Table 7** Association Between the Anemia Severity and the Clinical Characteristics of Postpartum Women

| Parameters                                     | Category      | Anemia Severity N (%) |                    | P-value          |
|------------------------------------------------|---------------|-----------------------|--------------------|------------------|
|                                                |               | Mild                  | Moderate to severe |                  |
| Any medical disease                            | Yes           | 14 (38.9)             | 22 (61.1)          | 0.513            |
|                                                | No            | 117 (44.7)            | 145 (55.3)         |                  |
| Laboratory anemia before labor                 | Anemic        | 55 (27.4)             | 146 (72.6)         | <b>&lt;0.001</b> |
|                                                | Non-anemic    | 76 (79.2)             | 20 (20.8)          |                  |
| Serum ferritin before labor                    | Normal        | 21 (55.3)             | 17 (44.7)          | 0.088            |
|                                                | Abnormal      | 14 (35.9)             | 25 (64.1)          |                  |
| Serum iron before labor                        | Normal        | 22 (57.9)             | 16 (42.1)          | <b>0.048</b>     |
|                                                | Abnormal      | 13 (35.1)             | 24 (64.9)          |                  |
| Serum total iron-binding capacity before labor | Normal        | 22 (56.4)             | 17 (43.6)          | 0.063            |
|                                                | Abnormal      | 13 (35.1)             | 24 (64.9)          |                  |
| Blood transfusion before labor                 | Yes           | 3 (14.3)              | 18 (85.7)          | <b>0.004</b>     |
|                                                | No            | 128 (46.2)            | 149 (53.8)         |                  |
| Postpartum hemorrhage (PPH)                    | Yes           | 8 (25.8)              | 23 (74.2)          | <b>0.031</b>     |
|                                                | No            | 123 (46.1)            | 144 (53.9)         |                  |
| Blood loss (mL)                                | ≤250          | 93 (47.7)             | 103 (52.6)         | <b>&lt;0.001</b> |
|                                                | 251–500       | 36 (47.7)             | 40 (52.6)          |                  |
|                                                | More than 500 | 2 (7.7)               | 24 (92.3)          |                  |
| Blood transfusion postpartum                   | Yes           | 4 (14.8)              | 23 (85.2)          | <b>0.001</b>     |
|                                                | No            | 127 (46.9)            | 144 (53.1)         |                  |

Note: A bolded p-value indicates statistical significance.

## Discussion

In this hospital-based, cross-sectional observational study, the incidence of anemia and its risk factors in the postpartum period was determined in Najran, Saudi Arabia. Anemia was prevalent in 52.7% of the postnatal women in this study. This finding aligns with previous studies in southern India (47.3%),<sup>11</sup> Ethiopia (47.16%),<sup>12</sup> and southeastern Kokang, Myanmar (56.3%),<sup>13</sup> which reported similar prevalence rates. In terms of severity, moderate anemia (55.4%) was frequent in this study. This was aligned with a similar study in India, which revealed 49.8% of moderate and 26% of mild anemia types.<sup>14</sup>

However, the findings of this study were lower than the prevalence found in Asia [eastern rural Myanmar] (60.3%). This discrepancy may be due to the coexistence of multiple risk factors, such as absence of primary education, poor socioeconomic status, and limited iron supplementations. Another reason could be the difference in sample sizes in Myanmar (n=733).<sup>15</sup> Lastly, it is well known that the erythropoiesis in the postpartum phase is shortened, and red blood cell mass is expanded; however, every Hb level returns to normal.<sup>11</sup> In contrast, this study reported higher prevalence rates compared to those in Japan (10.5%),<sup>16</sup> in Spain, Mancha-Centro Hospital (16.4%),<sup>18</sup> in Ghana (16%),<sup>17</sup> and northern Kenya (25%).<sup>18</sup> It may be attributed to geographical, cultural, clinical, and nutritional factors. Also, developed countries, such as Germany (25%),<sup>19</sup> North Carolina, and the USA (19.1%),<sup>19</sup> have lower prevalence. This variation can be explained by differences in geographical, cultural, clinical, and nutritional factors, as well as more frequent antenatal care (ANC) follow-ups, similar healthcare systems, and better healthcare-seeking behavior in developed countries.

The lack of a national agreement on the definition of PPA and the use of different Hb cutoff points in various studies also contribute to the observed discrepancies. Furthermore, variable postpartum screening times may influence the recovery from anemia, and lactation amenorrhea provides some protection against PPA by reducing the need for iron and blood loss post-menstruation. This study found that women with antenatal anemia were significantly more likely to develop PPA than others (85.9%). Parallel to other studies, we discovered that due to inappropriate iron intake, gestational and iron deficiency anemia were substantially linked to lower Hb and postpartum iron levels. A total of 83% of participants have abnormal serum ferritin, 84.1% have abnormal serum iron, and 82.2% have abnormal serum total iron-binding capacity.<sup>20,21</sup> Awareness of women about risk factors associated with anemia will decrease antenatal anemia and PPA. A meta-analysis revealed that pregnant women with enhanced knowledge of iron supplementation or anemia were likelier to use iron supplementation than women with limited knowledge. Health education about iron, folic acid, and anemia for pregnant and postpartum women should be provided in a simplified manner using different communication strategies aimed at changing nutritional behavior.<sup>22</sup>

In this study, moderate to severe anemia was also significantly more common among women with PPH than others (74.2%). Most studies showed that Hb decreases with PPH. Excessive blood loss during the delivery and postpartum causes Hb decline throughout the postpartum period.<sup>11</sup> It was consistent with this study since PPA is more common in those who needed antenatal blood transfusions (91.3%), postpartum blood transfusions (84.4%), and lost blood of more than 500 mL (86.7%). Moreover, moderate to severe anemia was significantly more prone among women with childbirth complications (79.2%). Mild anemia was significantly more common among women with multiparity (47.0%). This was supported by multiple studies, in addition to the missed ANC follow-ups, mode of delivery, and inadequate level of education, which were found to be independent risk factors for PPA.<sup>23–25</sup> However, these factors were not related to PPA in this study.

This study contributes to clinical practice by highlighting the importance of routine screening and early intervention for anemia during pregnancy and the postpartum period. It underscores the need for targeted care for high-risk groups and the implementation of comprehensive postpartum follow-up protocols. From a healthcare system perspective, advocating for policy changes to support access to prenatal and postnatal care is crucial. Socially and educationally, developing programs to raise awareness and educate women about anemia and its risk factors can help reduce its prevalence. Further research is needed to explore the underlying causes of anemia and to develop effective interventions for its prevention and management.

The study used primary data from different hospitals to elaborate a clear image of PPA in the study field.

Given the study's retrospective nature, a causal relationship might not be established, and behavioral factors were not assessed. Moreover, antepartum hemorrhage, anemia, and mode of delivery have been interlinked, but this association has not been investigated.

## Conclusion

This study highlights a significant prevalence of postpartum anemia among women, strongly linked to anemia prior to labor. Anemic participants are much more likely to develop postpartum anemia than non-anemic individuals. The severity of postpartum anemia is particularly greater in women with childbirth complications, those who have had one previous birth, or who were anemic before delivery. To address these issues, routine screening for anemia during antenatal visits, along with timely interventions like iron supplementation, is recommended. It's also important to focus on high-risk groups through specialized care plans and education on nutrition and iron intake during pregnancy. Comprehensive postpartum follow-up for changes to improve access to prenatal and postnatal care are essential strategies to reduce postpartum anemia and enhance maternal health outcomes.

## Abbreviations

ANC, antenatal care; BMI, body mass index; Hb, hemoglobin; PPA, postpartum anemia; PPH, postpartum hemorrhage.

## Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis, and interpretation, or in all these areas; took part in drafting, revising, or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

## Disclosure

The authors report no conflicts of interest related to the subject of this study.

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