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ORIGINAL ARTICLE

Association Between Maternal Anemia Severity and Neonatal Birth Weight: A Retrospective Observational Comparative Study

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Abstract

Background: Maternal anemia is a common condition during pregnancy and has been associated with adverse maternal and neonatal outcomes, including preterm delivery and low birth weight (LBW).

Objective: To evaluate the association between the severity of maternal anemia and neonatal birth weight.

Methods: A retrospective observational comparative study was conducted among 2079 women who delivered at Bahrain Defence Force Hospital between January and June 2021. Patients were categorized according to World Health Organization hemoglobin classifications into normal (>11 g/dL), mild anemia (10–10.9 g/dL), moderate anemia (7–9.9 g/dL), and severe anemia (<7 g/dL). Maternal demographics, obstetric characteristics, and neonatal outcomes were compared between groups.

Result: Normal hemoglobin levels were observed in 68.7%, mild anemia in 20.1%, and moderate-to-severe anemia in 11.2%. Mean neonatal birth weight was similar across all groups (3.1 ± 0.5–0.6 kg; P= 0.21). However, women with moderate-to-severe anemia delivered at an earlier gestational age and had higher rates of preterm delivery before 37 weeks (P=0.004).

Conclusion: Maternal anemia severity was not significantly associated with neonatal birth weight in this cohort. However, lower maternal hemoglobin levels were associated with earlier delivery and increased rates of preterm birth.

Keywords: Anemia, Hemoglobin, Low Birth Weight, Pregnancy, Preterm Delivery

Introduction

Low birth weight (LBW) is defined as a weight less than 2499 g in a newborn baby, regardless of the gestational age. The overall rate of LBW births worldwide is around 15-20%, which accounts for more than 20 million babies per year.[1] Anemia is a major public health concern affecting both developed and developing countries. Its prevalence is approximately 5.4% in developed countries, whereas it exceeds 80% in some developing countries.[2] Furthermore, it is indicated as a direct and indirect cause of maternal and fetal morbidity and mortality.[3]

The World Health Organization (WHO) classifies anemia levels as normal (>11 g/dL), mild (10-10.9 g/dL), moderate (7-9.9 g/dL), and severe (< 7 g/dL).[1,4] Anemia in pregnancy can be physiological due to an increase in plasma volume exceeding the rise in red blood cell mass, causing hemodilution and a consequent decrease in hemoglobin levels.[5] Around 30% of reproductive-age women worldwide are anemic, and the prevalence of pregnancy anemia is 38%.[6] Severe anemia can increase the risk of maternal mortality and affect fetal development.[7]

Iron deficiency anemia is a risk factor for preterm delivery, LBW, and small size for gestational age.[8-11] The rate of anemia can be over 50% in some populations, such as Saudis (58.9%) and Central/West Africans (56%).[6,12] Yet some countries have low rates, China (10.5%), Japan (10.5%), and the United States (5.6%).[13-15] Europe has variable rates of 28-85% among different populations, while the rate of anemia in pregnancy in Bahrain is 34.3%.[16,4]

The prevalence of LBW can be as low as 20% in areas such as Latin America (9%), Iran (9.1%), and Ethiopia (9.1-17.9%).[17-20] However, some areas have a higher rate of more than 25%, such as Nepal (11.9-39.6%), South Asia (28%), and India (33%).[21-23] According to the WHO, neonates with LBW have a higher risk for neonatal mortality than those who have normal birth weight. They also have a higher risk of infection, respiratory problems, hypoglycemia, hypothermia, and birth asphyxia.[24]

There is a controversial relationship between the severity of maternal anemia and birth weight. Some studies report that anemia is associated with LBW, while others did not demonstrate any association between anemia and LBW.[4,25-28] Thus, this study aims to investigate the relationship between maternal anemia and birth weight.

Materials and Methods

A retrospective observational comparative study was conducted at Bahrain Defence Force (BDF) Hospital, Bahrain. The study included all women who delivered between January and June 2021. Ethical approval was obtained from the Royal Medical Services Research and Ethics Committee, Bahrain Defence Force Hospital (Approval No: 357/2019). Maternal demographic and clinical characteristics were extracted from electronic medical records, including maternal age, nationality, body mass index (BMI), parity, previous miscarriage, history of preterm delivery, lower segment cesarean section (LSCS), antenatal care (ANC) booking status, and maternal medical history. Maternal medical history included diabetes mellitus, hypertension, platelet disorders, sickle cell trait (SCT), infertility, and a history of gastric sleeve surgery. Pregnancy-related variables included placental abnormalities, fetal anomalies, serology status, vaginal infections, gestational age at delivery, mode of delivery, fetal sex, and neonatal birth weight. Hemoglobin values recorded during the third trimester of pregnancy were retrieved from antenatal records. When multiple hemoglobin measurements were available, the lowest recorded hemoglobin level during the third trimester was used for the analysis. Patients were categorized according to hemoglobin level as follows: normal hemoglobin (>11 g/dL), mild anemia (10.0–10.9 g/dL), and moderate-to-severe anemia (<10.0 g/dL). Nationality was classified into three categories: Gulf countries, Asian countries, and other nationalities. Data were analyzed using StatsDirect statistical software version 3.3.5 (Merseyside, UK). Continuous variables with normal distribution were compared using one-way analysis of variance (ANOVA), while non-normally distributed variables were analyzed using the Kruskal-Wallis test. Categorical variables were compared using chi-square analysis or the Fisher-Freeman-Halton exact test when appropriate. A P-value of <0.05 was considered statistically significant.

Results

Hemoglobin (Hb) levels were more than 11 g/dL in 1429 patients (68.7%), between 10.1 and 11 g/dL in 417 patients (20.1%), and between 7 and 10 g/dL in 233 patients (11.2%). The incidence of anemia was 31%, and that of severe anemia was 11%. Patients with mild anemia were significantly older in this cohort. Furthermore, the same group with mild anemia had a higher BMI level than other groups, but the difference was not statistically significant. There was no difference in the nationality profile between the groups, and the majority of patients were from the Gulf area. Patients with normal Hb levels had lower parity than patients with any degree of anemia (P=0.004). All groups were matched for previous history of miscarriage, preterm delivery, and caesarean delivery (Table 1).

In general, there was no difference in past medical history between the groups. Patients with mild anemia had higher incidences of platelet disorders, diabetes, and hypertension, but the difference did not reach statistical significance. Sickle cell trait (SCT), history of gastric sleeve surgery, and infertility were seen more in patients with severe anemia, but the difference was not significant (Table 2).

Although most of the patients in this study had booked prenatal care, the data showed that patients with severe anemia had the lowest booking rate (P=0.02). Furthermore, patients with severe anemia had higher incidences of fetal and placental abnormalities (2.2% and 6%, respectively), but this did not reach statistically significant levels. Serology statuses were all similar in all groups, including hepatitis, HIV, syphilis, and rubella results. Patients with mild anemia had a higher incidence of *Candida* infection (P=0.006). The incidence of bacterial vaginosis was similar between the groups (Table 3).

Patients with severe anemia tended to deliver earlier than other groups and had a mean gestational age of 37.9 gestational weeks (P=0.002). They also had a higher incidence of preterm delivery at less than 37 gestational weeks (P=0.004). The rate of caesarean delivery was higher among patients with mild anemia than among those in the other groups; however, the difference was not statistically significant. No significant differences were observed among the three groups with respect to multiple pregnancies, fetal sex, birth weight, or the proportion of infants with a birth weight <2.5 kg (Table 4).

Table 1: Demographic details of study population

Hb	Group A >11 N 1429	Group B 10.1-11 N 417	Group C <10 N 233	P value
Maternal age years mean ± SD	29.5± 5.9	30.4± 6.3	29.4 ±6.4	0.01*
BMI kg/m^2 mean ± SD	30.9± 6.1	31.5± 6.3	30.9± 6.5	0.23*
Nationality Gulf Asian Others	 1061(74.3%) 163 (11.4%) 205 (14.3%)	 301 (72.2%) 48 (11.5%) 68 (16.3%)	 180 (77.3%) 20 (8.6%) 33 (14.1%)	0.57***
Parity median (range)	1 (0-21)	2 (0-10)	2 (0-21)	0.004**
Previous miscarriages mean ± SD	0.4 ± 0.7	0.4 ± 0.9	0.3 ± 0.7	0.25*
Previous preterm delivery	35 (2.5%)	5 (1.2%)	7 (3%)	0.23***
Previous Lower segment cesarean section	185 (12.9%)	65 (15.6%)	33 (14.2%)	0.37***

*One-way analysis of variance **Kruskal-Wallis test ***Chi-square test

Table 2: Baseline maternal medical history

HB	Group A >11 N 1429	Group B 10.1-11 N 417	Group C <10 N 233	P value
Past medical history*	41 (2.9%)	11 (2.6%)	9 (3.9%)	0.65***
Platelet disorder	8 (0.6%)	3 (0.7%)	1 (0.4%)	0.89****
Diabetes mellitus	187 (13.1%)	60 (14.4%)	23 (9.9%)	0.25***
Hypertension	49 (3.4%)	17 (4.1%)	7 (3%)	0.74***
Sickle cell trait	11 (0.8%)	4 (0.9%)	3 (1.3%)	0.57****
Gastric sleeve	7 (0.5%)	3 (0.7%)	2 (0.9%)	0.54****
Infertility	26 (1.8%)	4 (0.9%)	3 (1.3%)	0.51****

* PMH included chronic respiratory disease, thyroid disorders, renal disease, and autoimmune conditions.
*** Chi-square test**** Fisher-Freeman-Halton exact

Table 3: Characteristics during pregnancy

Hb	Group A >11 N 1429	Group B 10.1-11 N 417	Group C <10 N 233	P value
Booked Antenatal care	1277 (89.4%)	388 (93.1%)	202 (86.7%)	0.02***
Fetal anomalies	13 (0.9%)	3 (0.7%)	5 (2.2%)	0.19****
Placental abnormalities	64 (4.5%)	19 (4.6%)	14 (6%)	0.59***
Serology +ve	127 (8.9%)	46 (11%)	21 (9%)	0.41***
Candida infection	230 (16%)	95 (22.1%)	45 (19.3%)	0.006***
Bacterial vaginosis	226 (15.8%)	72 (17.3%)	38 (16.3%)	0.78***

*** Chi-square test**** Fisher-Freeman-Halton exact

Table 4: Pregnancy outcome

Hb	Group A >11 N 1429	Group B 10.1-11 N 417	Group C <10 N 233	P value
Delivery gestational weeks mean ± SD	38.4 ± 1.8	38.2 ± 2	37.9 ± 2.6	0.002*
Vaginal delivery Caesarean delivery	1109 (77.6%) 320 (22.4%)	302 (72.4%) 115 (27.6%)	178 (76.4%) 55 (23.6%)	0.09***
Multiple pregnancy	44 (3.1%)	13 (3.1%)	7 (3%)	0.99***
Fetal gender Female Male	 714 (50%) 715 (50%)	 197 (47.2%) 220 (52.8%)	 123 (52.8%) 110 (47.2%)	0.38***
Birth weight Kg mean ± SD	3.1 ± 0.5	3.1 ± 0.6	3.1 ± 0.6	0.21*
Birth weight <2.5 kg	147 (10.3%)	35 (8.4%)	31 (13.3%)	0.14***
Preterm delivery <37 weeks	146 (10.2%)	61 (14.6%)	38 (16.3%)	0.004***

*One way analysis of variance *** Chi-square test

Discussion

Anemia is a common global health problem that affects both developed and developing countries, although its prevalence varies considerably across regions and populations.[2] It is indicated as a direct and indirect cause of maternal and fetal morbidity and mortality.[3] Iron deficiency anemia is a risk factor for preterm birth, LBW, and small size for gestational age.[8-10]

The overall prevalence of anemia in our study was 45.5% (650/1,429), which was higher than reported in East Asia and North America but lower than reported in Saudi Arabia and Central/West Africa.[6,12,13,15] Possible contributing factors may include nutritional status, healthcare access, and socioeconomic differences; however, these variables were not assessed in the present study. The influence of socioeconomic status on the prevalence of anemia was demonstrated in a prospective cohort study, which showed a higher rate of Hb levels < 10.5 g/dL in patients with lower socioeconomic status.[29]

Our data study indicated that patients with severe anemia had the lowest rate of prenatal booking status (P=0.02). Patients who do not book prenatal care may have a low Hb level during pregnancy that remains undetected. Owolabi et al., concluded that patients who do not book prenatal care have a significantly higher incidence of anemia than patients who do book it.[30] Interestingly, we noticed a higher incidence of vaginal deliveries and a lower incidence of cesarean deliveries among patients with Hb >11 g/dL. Drukker et al., observed a high incidence of cesarean deliveries among anemic patients.[31] This emphasizes the fact that those with higher Hb levels tend to have lower obstetric risk.

In our study, the birth weight was comparable across all study groups, but the incidence of LBW was higher among those with Hb < 10 g/dL, consistent with the findings reported by Malhotra et al. They found a prevalence of anemia of 72.5%, as well as a 10.5-fold increase in risk of having LBW infants in severe anemic mothers (Hb ≤ 7.5 g/dL).[32] Another study concluded that LBW was associated with maternal anemia, especially among women with Hb < 8 g/L.[33] In contrast, among a cohort study of 422 patients in Tanzania, only 16 cases (3.6%) had LBW with no anemic mother (Hb < 11 g/dL).[3] Javadi et al., reported that maternal hemoglobin concentration was not significantly associated with neonatal birth weight.[34]

Kuar et al., compared adverse birth outcomes between anemic and non-anemic mothers and found that maternal hemoglobin status was an important predictor of neonate weight and length.[35] Stillbirth cases were not detected among anemic patients in our study. Studies in China and Tanzania also found no association between anemia and stillbirth.[36,27] In contrast, cohort studies in Scotland and India found that maternal anemia was associated with increased risk of stillbirth.[37,38]

The absence of a statistically significant association between maternal anemia severity and neonatal birth weight in this cohort may be explained by several factors. First, most patients had mild rather than severe anemia, which may have reduced the measurable impact on fetal growth. Second, antenatal surveillance and iron supplementation may have minimized adverse neonatal outcomes. Third, adjustment for confounding variables such as maternal education, income, and nutritional status. In addition, the retrospective design and inclusion of heterogeneous maternal comorbidities may have introduced residual confounding.

Furthermore, lower maternal hemoglobin levels have been associated with earlier delivery rather than a direct reduction in birth weight.

Limitations

This study has several limitations. All patients were included without exclusion criteria, resulting in a heterogeneous population. Maternal conditions such as diabetes mellitus, hypertension, sickle cell trait, multiple pregnancy, and previous gastric sleeve surgery may independently affect pregnancy outcomes and neonatal birth weight. The number of patients with sickle cell disease included in this study was limited because they are typically managed at Ministry of Health hospitals with dedicated sickle cell centers. Furthermore, socioeconomic status, maternal education, occupation, and nutritional status were not evaluated, limiting the ability to assess their potential influence on maternal anemia and pregnancy outcomes.

Conclusion

In this retrospective observational comparative study, maternal anemia severity was not significantly associated with neonatal birth weight. However, lower maternal hemoglobin levels were associated with earlier gestational age at delivery and increased rates of preterm birth. Further prospective studies that control for maternal comorbidities and socioeconomic factors are recommended.

Conflict of Interest

Nil

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