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Comparison of pregnancy outcomes in pregnant women (third trimester) with and without anemia: a case-control study from Iran

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Abstract

Objectives: This study aimed to compare pregnancy outcomes in pregnant women in the third trimester with and without anemia.

Methods: A case-control study was conducted, involving 144 pregnant women with anemia (case group) and 144 pregnant women without anemia (control group) receiving prenatal care in the third trimester between April 2021 and March 2022. Various maternal and neonatal clinical outcomes, such as response to iron intake, incidence of preeclampsia during delivery, rates of cesarean section, postpartum infections, small for gestational age (SGA) infants, Apgar scores at 1 and 5 minutes, and birth weight, were recorded and compared between the two groups.

Results: Mean hemoglobin and hematocrit levels were significantly lower in women with anemia compared to those in the control group ($p<0.001$). The response rate to iron supplementation was 21.5% in anemic women and 97.2% in non-anemic women ($p<0.001$). SGA incidence in the case group was 7.6% (11 cases), while it was 2.1% (3 cases) in the control group ($p=0.028$). Although pre-eclampsia, cesarean section rates, and infant birth weights were lower in the case group compared to the control group, these differences were not statistically significant. No significant differences were observed in the rates of cesarean section, episiotomy site infections, Apgar scores at 1 and 5 minutes between the two groups.

Conclusion: The results of this study indicate a correlation between maternal anemia and adverse neonatal and maternal outcomes, with a significantly higher incidence of SGA among anemic women. Therefore, healthcare providers in preconception care settings should identify anemic women prior to pregnancy initiation and provide appropriate interventions through dietary adjustments and supplements to mitigate adverse pregnancy outcomes.

Keywords: Anemia, Women, Pregnancy, Maternal outcome, Neonatal outcome.

Introduction

One of the physiological variables in pregnancy that can potentially endanger the health of the fetus and women is hematological disorders, especially anemia. Anemia is a significant nutritional and health disorder that can lead to complications for both women and the fetus. The prevalence of anemia in women of reproductive age is higher due to factors such as menstrual bleeding and pregnancy. Particularly in developing countries, anemia is more common due to inadequate nutrition and lack of iron supplementation.[1,2] Women's iron requirements during pregnancy are approximately 800 mg, with around 300 mg allocated to the placenta and fetus, and 500 mg needed to increase the women's hemoglobin volume. Approximately 200 mg of iron is excreted through feces, urine, and skin. This total need of 1000 mg exceeds the iron reserves of most women.[3]

Anemia tends to be more prevalent among economically disadvantaged pregnant women, but it can affect women across all socioeconomic backgrounds.[2] According to the American College of Obstetricians and Gynecologists (ACOG), the causes and prevalence of anemia vary based on factors such as geographic location, ethnicity, nutritional status, iron levels, prenatal iron

supplementation, and economic and social factors.[4] Globally, around 40% of pregnant women are affected by anemia, with approximately one-third of pregnant women in the United States experiencing this condition.[5,6] In Asian countries like India, Pakistan, Bahrain, and the Emirates, the prevalence of anemia during pregnancy ranges from 14% to 90.5%.[7-9] In Iran, studies have reported varying prevalence rates of anemia during pregnancy, ranging from 4.3% to 28.5%.[10]

Iron deficiency anemia is the most common form of anemia during pregnancy and can be effectively prevented with iron supplementation. This preventive measure can help mitigate the complications associated with maternal anemia for both the mother and the fetus. During pregnancy, a slight decrease in hemoglobin levels in healthy women without iron or folate deficiencies is attributed to a greater increase in plasma volume compared to red blood cell volume. The second trimester typically sees the greatest disparity between plasma and erythrocyte volume increases. By late pregnancy, while hemoglobin levels continue to rise, plasma volume expansion stabilizes. These physiological changes, including increased blood volume and alterations in hemostasis, aid in managing the risk of bleeding during and after delivery. The resultant dilutional decrease in hemoglobin concentration is termed physiological anemia in pregnancy, peaking around the 32nd week.[11,12]

Anemia during pregnancy and the postpartum period are common contributors to iron deficiency and acute bleeding. Excessive bleeding and subsequent depletion of iron reserves during one pregnancy can set the stage for iron deficiency anemia in subsequent pregnancies.[13]

Anemia is typically defined by hemoglobin levels falling below the normal range. The normal hemoglobin level for adult women is approximately 12±4 g/dL. The ability to carry oxygen is determined by the amount of hemoglobin per unit volume of blood.[14] According to the Centers for Disease Control (CDC), anemia during pregnancy is diagnosed when hemoglobin concentrations fall below 11 g/dL in the first and third trimesters and below 10.5 g/dL in the second trimester.[15]

Compared to healthy women, those with anemia face a higher risk of childbirth complications. Anemia is associated with an increased likelihood of premature delivery and decreased birth weight, head circumference, chest circumference, and height of the baby. Low birth weight is a significant factor contributing to infant mortality, which is three times more prevalent in anemic women compared to their healthy counterparts. Women experiencing a decline in hemoglobin levels are at an elevated risk of premature delivery and fetal growth restriction. According to studies conducted by the World Health Organization (WHO), anemia has been implicated in 40% of maternal deaths in developing countries. In cases where women have multiple pregnancies with short intervals between them, insufficient time for the replenishment of nutritional reserves poses a heightened risk of fetal complications. When examining the impact of anemia on pregnancy outcomes, considering the etiology of anemia is crucial. For instance, in women with sickle cell anemia, both maternal and perinatal outcomes can be significantly altered due to vascular complications associated with red blood cell sickling.[16,17]

Overall, anemia can lead to various complications for both women and their babies. While some studies have demonstrated a clear link between anemia and maternal as well as fetal complications, others have shown less consistent results, with some even reporting contradictory findings.[1,2]

Objectives

Therefore, recognizing the significance of anemia in pregnant women, given its potential negative effects on both maternal health and fetal well-being, this study aims to compare pregnancy outcomes in women in their third trimester with and without anemia.

Methods

Study Setting and Participants

This case-control study evaluated all pregnant women receiving care at Tajrish Hospital in Tehran, Iran, from April 2021 to March 2022, who were in the third trimester of pregnancy.

Women with anemia in the third trimester were assigned to the case group, while those without anemia comprised the control group. Inclusion criteria involved women who underwent either caesarean section or vaginal delivery and provided informed consent. Exclusion criteria included other forms of maternal anemia and hemoglobinopathies, bleeding disorders, underlying conditions such as diabetes, gestational or pre-existing hypertension, history of major surgeries, presence of thromboembolism, placental issues like abruption or previa, uterine myoma, and polyhydramnios.

Sample Size

Based on a prior study,[18] with 80% power and a 5% type 1 error rate, the sample size was estimated at 144 individuals per group. Convenience sampling was utilized to select eligible participants for this study.

Data Collection

Researchers obtained access to participants' medical records by coordinating with hospital management and securing necessary permissions. Data were recorded in a preliminary checklist and subsequently entered into an electronic database by a trained research team. Incomplete files were excluded, and missing data were clarified through communication with treating clinicians.

Variables such as age, weight, height, hemoglobin levels, hematocrit, mean corpuscular volume (MCV), history of abortion, smoking habits, alcohol consumption, and various clinical outcomes including response to iron intake, occurrence of preeclampsia during delivery, cesarean section rates, post-delivery infections, small for gestational age (SGA) infants, Apgar scores at one and five minutes, and neonatal birth weight were recorded and compared between the two groups.

Statistical Analysis

Continuous variables were presented as mean ± standard deviation (SD), while categorical variables were expressed as percentages. Chi-square and independent t-tests were used for intergroup comparisons. Statistical analyses were conducted using SPSS software (version 16.0, SPSS Inc., Chicago, IL, USA). A "P-value" less than 0.05 was considered significant.

Ethical Considerations

This study received approval from the ethics committee of Shahid Beheshti University of Medical Sciences (code: IR.SBMU.MSP.REC.1400.103) and adhered to the principles outlined in the Declaration of Helsinki. Participants provided informed consent, and the research did not incur any additional costs for the women or interfere with their diagnosis or treatment processes.

Results

Demographic and Clinical Characteristics of Women

In this study, 144 women with anemia (case group) and 144 women without anemia (control group) receiving prenatal care in the third trimester of pregnancy were examined. There were no significant differences in mean age and BMI between the two groups, and none of the women reported smoking or alcohol consumption.

According to Table 1, 61.1% of women with anemia and 72.9% of women without anemia had parity one. Additionally, 8.3% of women with anemia had parity four, while this value was 0% in women without anemia (P<0.001). Mean hemoglobin and hematocrit levels were significantly lower in women with anemia compared to the control group (P<0.001). There was no significant difference in the history of abortion and mean MCV between the two groups.

Table 1. Demographic and Clinical Characteristics of 144 Women with Anemia (Case Group) and 144 Women without Anemia (Control Group)

		Case group (n=144)	Control group (n=144)	P value
Age (years)	Mean±SD	30.5±4.5	29.1±5.8	0.32
BMI (kg/m^2)	Mean±SD	27.6±3.7	28.2±5	0.29
Hb	Mean±SD	10.2±0.6	11.9±0.6	<0.001
Hct	Mean±SD	31.6±2.1	35.6±1.9	<0.001
MCV	Mean±SD	85.8±6.2	87±11.1	0.23
Parity	1; N (%)	88 (61.1)	105 (73)	<0.001
	2; N (%)	36 (25)	15 (10.4)	
	3; N (%)	8 (5.6)	24 (16.7)	
	4; N (%)	14 (8.3)	0	
Previous abortion	N (%)	41 (28.5)	37 (25.7)	0.59

Maternal and Neonatal Clinical Outcomes

The response rate to iron therapy in women with anemia was 21.5%, while it was 97.2% in women without anemia (P < 0.001). The frequency of small for gestational age (SGA) infants in the case group was 7.6% (11 cases), compared to 2.1% (3 cases) in the control group (P=0.028).

Pre-eclampsia, cesarean section rates, and infant birth weight in the case group were lower than in the control group, but these differences were not statistically significant [Table 2]. There were no significant differences between cesarean section and episiotomy site infections, as well as Apgar scores at one and five minutes, between the control and case groups.

Table 2. Maternal and Neonatal Outcomes in 144 Women with Anemia (Case Group) and 144 Women without Anemia (Control Group)

		Case group (n=144)	Control group (n=144)	P value
Response to iron intake	N (%)	31 (21.5)	140 (97.2)	<0.001
Pre-eclampsia	N (%)	2 (1.4)	4 (2.8)	0.49
Cesarean	N (%)	91 (63.2)	94 (65.3)	0.72
Infection after delivery	N (%)	13 (9)	9 (6.3)	0.37
SGA	N (%)	11 (7.6)	3 (2.1)	0.028
Neonate weight, g	Mean±SD	3098.9±618.4	3209.2±549.4	0.11
Apgar 1	Median (min-max)	9 (8-9)	9 (8-9)	0.098
Apgar 5	Median (min-max)	10 (9-10)	10 (9-10)	0.344

Discussion

In this study, 144 women with anemia (case group) and 144 women without anemia (control group) in the third trimester of pregnancy were examined. There was no significant difference in mean age and BMI between the two groups. Previous studies by Akbari et al. have indicated a significant association between BMI and the development of anemia during pregnancy.[19] Similarly, Bondevik et al. suggested that anemia during and after pregnancy is linked to BMI, with obesity being a potential cause of post-pregnancy anemia.[20] Ali et al. found no statistically significant difference in age between anemic and non-anemic groups, although the mean age was lower in the severe anemia group, possibly due to factors such as early marriage, higher parity, inadequate prenatal care, and unfavorable socio-economic status.[21] Consistent with our findings, Preeti et al. reported a significant difference in parity between anemic and non-anemic pregnant women, with 61.1% of anemic women having parity one compared to 72.9% of non-anemic women (p<0.001).[22]

The mean hemoglobin and hematocrit levels were significantly lower in the anemia group compared to the control group (p<0.001). The history of abortion was slightly higher in the anemia group than in the control group. Savajole et al. demonstrated that lower hemoglobin levels in the first trimester of pregnancy are associated with adverse neonatal outcomes in premature births.[23]

Our results indicated a higher rate of postpartum infection in women with anemia compared to those without, although this difference was not statistically significant. Consistent with our findings, Richards et al. reported higher rates of postpartum urinary tract infections and antibiotic use in anemic women, with babies born to anemic mothers showing elevated rates of sepsis after birth.[24]

Ren et al. found that decreased hemoglobin levels in the first trimester increase the risk of low birth weight, preterm birth, and small for gestational age (SGA).[25] In our study, we observed an increased risk of SGA in women with anemia, while other outcomes such as infant weight did not show significant differences between the groups.

Additionally, severe anemia in pregnant women has been linked to a higher risk of preeclampsia and poor pregnancy outcomes.[21] Karashin et al. also reported higher rates of preeclampsia in anemic women compared to non-anemic women.[26] In our study, although the rates of preeclampsia, cesarean section, and infant birth weight were lower in women with anemia compared to the control group, these differences were not statistically significant.

Shah et al., in Pakistan also demonstrated that anemia during pregnancy significantly increases the risk of low Apgar score, low birth weight, small for gestational age (SGA), preterm delivery, and cesarean section.[18] Bora et al. showed that severe maternal anemia was associated with shorter gestation, lower birth weight, and an 89% increased risk of SGA compared to women without anemia. These results align somewhat with the findings of our study, which indicated a significant relationship between maternal anemia and SGA, though this significance did not hold true for other fetal outcome variables.[27] Umber et al. reported that anemic women had a higher risk of premature delivery, low birth weight, and low Apgar score in the first minute compared to non-anemic women.[28]

In general, inconsistent results have been reported in different countries, which could be related to cultural and economic conditions, gestational age, nutritional status, prenatal care, and other factors. It appears that many young women begin their first pregnancy with low iron stores. Pregnancy increases the demand for iron and disrupts the iron balance, leading to iron deficiency anemia if adequate iron intake is not maintained through diet. In addition to the complications it poses for women, anemia during pregnancy increases fetal complications. Reducing anemia through iron supplementation during

pregnancy can help mitigate these complications.[29,30]

It is recommended to conduct a national-level study with a larger sample size in Iran to explore additional outcomes. Providing pre-pregnancy counseling to Iranian women for early detection and treatment of anemia is crucial to prevent adverse pregnancy outcomes.

Conclusions

In conclusion, our study findings revealed the association of maternal anemia with neonatal and maternal complications, with SGA being significantly higher in anemic women compared to non-anemic women. Furthermore, rates of cesarean section and infant birth weight were lower in the anemia group, although these differences were not statistically significant. Since iron deficiency anemia is a preventable nutritional disorder, it is advised that pregnancy care programs include adequate iron supplementation to meet the iron needs of both women and their fetuses.

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Competing interests

The authors declare that they have no competing interests.

Abbreviations

American College of Obstetricians and Gynecologists: ACOG;

Center for Disease Control: CDC;

World Health Organization: WHO;

Mean corpuscular volume: MCV;

Small for gestational age: SGA;

Body mass index: BMI.

Authors' contributions

All authors read and approved the final manuscript. All authors take responsibility for the integrity of the data and the accuracy of the data analysis.

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Availability of data and materials

The data used in this study are available from the corresponding author on request.

Ethics approval and consent to participate

This study received approval from the ethics committee of Shahid Beheshti University of Medical Sciences (code: IR.SBMU.MSP.REC.1400.103) and adhered to the principles outlined in the Declaration of Helsinki. Participants provided informed consent, and the research did not incur any additional costs for the women or interfere with their diagnosis or treatment processes.

Consent for publication

By submitting this document, the authors declare their consent for the final accepted version of the manuscript to be considered for publication.

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