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Research Article

Maternal Iron and Folic Acid Deficiency in Pregnancy and Its Relationship with Maternal and Neonatal Haemoglobin Concentration

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ABSTRACT

Background: The nutritional status of iron and folic acid deficiency in pregnancy is common and can be associated with maternal anemia and poor neonatal hematological status. Mother's haemoglobin is vital to carry oxygen to the unborn and to the newborn baby and play an important role in fetal growth and baby's wellbeing.

Objective: To determine the frequency of maternal iron and folic acid deficiency during pregnancy and to assess its relationship with maternal and neonatal haemoglobin concentration.

Methods: A descriptive cross-sectional study was done at Swat Medical Complex Teaching Hospital from January 2025 to June 2025. The total pregnant women were collected by non-probability consecutive sampling technique of 75 women. A structured proforma was used to gather maternal demographic, obstetric, antenatal and supplementation information. Haemoglobin, serum ferritin, serum iron and serum folate levels were measured. After birth, the level of haemoglobin in the blood of the baby was measured and the effects of birth were noted. The SPSS software was used for data analysis. All categorical variables were given frequencies and percentages, and all quantitative variables were calculated using mean and standard deviation. Data were analyzed using independent sample t-test, chi-square test and Pearson correlation, as appropriate. A p-value value of < 0.05 was regarded as significant.

Results: The mean maternal haemoglobin concentration was 10.1 ± 1.4 g/dL, and maternal anemia was observed in 49 (65.3%) women. Iron deficiency was present in 42 (56.0%), folic acid deficiency in 31 (41.3%), and combined iron and folic acid deficiency in 24 (32.0%) women. Women with iron deficiency had significantly lower maternal haemoglobin levels than non-deficient women (9.4 ± 1.1 g/dL vs. 11.0 ± 1.2 g/dL, $p < 0.001$). Folic acid deficiency was also significantly associated with lower maternal haemoglobin concentration ($p = 0.002$). The mean neonatal haemoglobin concentration was 14.7 ± 1.6 g/dL. Neonates born to iron-deficient and folic acid-deficient mothers had significantly lower haemoglobin levels. A moderate positive correlation was observed between maternal and neonatal haemoglobin concentration ($r = 0.58$, $p < 0.001$).

Conclusion: Maternal iron and folic acid deficiency were common during pregnancy and were significantly associated with reduced maternal and neonatal haemoglobin concentration. Regular antenatal screening, dietary counseling, and improved compliance with iron and folic acid supplementation are recommended to improve maternal and neonatal hematological outcomes.

Keywords: Iron Deficiency, Folic Acid Deficiency, Pregnancy, Maternal Haemoglobin, Neonatal Haemoglobin, and Anemia.

INTRODUCTION

There are higher nutritional requirements during pregnancy due to the mother's need to provide for changes in her physiology and the growth and development of the fetus. This is a time when the need for iron and folic acid rises significantly as a result of the growth in maternal blood volume, development of the placenta, fetal erythropoiesis and the preparation of blood for loss at delivery. These additional nutritional demands, if not met, can result in micronutrient deficiencies, especially iron deficiency and folic acid deficiency, in pregnant women (1-3).

Iron is an integral part of haemoglobin, and is also involved in the transport of oxygen from mother to fetus. During pregnancy, low maternal iron consumption, low iron absorption, subsequent pregnancies, birth spacing, low socioeconomic status, and noncompliance with iron supplementation may result in depletion of maternal iron stores. One of the most important causes of anemia in pregnancy is iron deficiency. This can lead to poor tolerance of blood loss, maternal fatigue, reduced work capacity, poor tolerance of infection, and poor pregnancy outcomes (4-6).

Another important micronutrient that is needed during pregnancy is folic acid. It is required for DNA formation, red blood cell production and normal fetal development. Folic acid deficiency impairs erythropoiesis and can be a cause of maternal anemia. Folic acid deficiency in early pregnancy is also a high risk of poor fetal development, particularly neural tube defects. Hence, folic acid plays a vital role in the health of both the mother and the baby, so it is critical to get enough folic acid before and during pregnancy .(7, 8)

Haemoglobin concentration of the mother is also a valuable parameter for the assessment of maternal haematological condition in pregnancy. Low maternal Hb can be associated with poor delivery of oxygen to the fetus, and have been linked to low birth weight, premature birth, poor iron stores in the neonate and low neonatal Haemoglobin concentration. The neonatal haemoglobin level depends on various factors in the mother and foetus, but maternal iron and folate status are thought to be important. Low maternal micronutrient status can decrease the transfer of micronutrients to the fetus and can have a negative impact on neonatal blood formation (9, 10).

Anemia during pregnancy continues to be a significant public health issue in developing countries. In many pregnant women, antenatal services are commenced late and dietary diversity is low, and iron and folic acid supplements are not taken regularly. Nutritional deficiencies are also underdiagnosed locally until the onset of anemia. Identification of iron and folic acid deficiencies early in pregnancy is, therefore, important to avoid maternal anemia and better neonate outcome (11).

Poor compliance and lack of awareness are important barriers to receiving iron and folic acid supplements during pregnancy, since they are routinely recommended. There is also a need for local evidence of the association between maternal micronutrient deficiency and neonatal haemoglobin concentration. It is important to understand this relationship and ensure antenatal screening, counseling, supplementation strategies and neonatal care planning is improved (12).

Therefore, the present study was conducted to determine the frequency of maternal iron and folic acid deficiency during pregnancy and to assess its relationship with maternal and neonatal haemoglobin concentration among pregnant women at Swat Medical Complex Teaching Hospital.

MATERIALS AND METHODS

This descriptive cross-sectional study was conducted at Swat Medical Complex Teaching Hospital from January 2025 to June 2025. The study was designed to determine the frequency of maternal iron and folic acid deficiency during pregnancy and to assess its relationship with maternal and neonatal haemoglobin concentration. A total of 75 pregnant women fulfilling the selection criteria were included in the study.

Non-probability consecutive sampling was used to select pregnant women who attended the antenatal clinic and who were admitted for delivery during the study period. The third trimester of pregnancy and those pregnant for delivery were all included. Only women with informed consent and singleton pregnancy with available maternal and neonatal haemoglobin measurements were included. The pregnant women with chronic renal disease, chronic liver disease, known haemoglobinopathies, antepartum hemorrhage, multiple pregnancy, severe acute infection and blood transfusion during pregnancy were excluded because such conditions can independently affect the haemoglobin concentration.

Informed consent was obtained and detailed information obtained from each participant using a structured proforma. Age, place of residence, level of education, socioeconomic status, and occupation were maternal demographic data. Obstetric information, which included, gestational age, gravidity, parity, birth spacing, antenatal care visits, and history of iron and folic acid supplementation during pregnancy. Supplementation status was determined by patient history and available antenatal records as regular, irregular or no supplementation.

Nutrient and haematologic status of the mothers was evaluated during their recruitment or admission for delivery. Maternal haemoglobin, serum ferritin, serum iron and serum folate level were determined from venous blood samples collected under aseptic conditions. Haemoglobin concentration was determined in g/dl. Serum ferritin level was used as the primary indicator of iron deficiency and serum folate level was used as the primary indicator of folic acid deficiency. Anemia was defined on the basis of haemoglobin concentration as mild, moderate or severe anemia. Those women that had low iron status and low folate level were classified as combined iron and folic acid deficiency.

Neonatal data were taken at the time of birth. These comprised gender of the newborn, birth weight, gestational maturity, APGAR score, neonatal haemoglobin concentration, low birth weight and requirement for admission to the NICU. Cord blood or early neonatal blood sample was used for neonatal haemoglobin measurements (as per hospital protocol). Low birth weight was classified as birth weight of < 2.5 kg. Assessment of the relationship between maternal deficiency status and neonatal haemoglobin concentration to determine if there was an association between reduced maternal micronutrient status and a reduced neonatal haemoglobin concentration.

The data collected was entered and analysed with SPSS software. Data for quantitative variables like maternal age, maternal haemoglobin, neonatal haemoglobin, serum ferritin, serum folate and birth weight were given as mean and standard deviation. The residence, education, parity, anemia status, iron deficiency, folic acid deficiency, supplementation status, low neonatal haemoglobin, low birth weight, and admission to NICU were summarized as frequencies and percentages for qualitative variables. The mean haemoglobin levels of deficient and non-deficient groups were compared using independent sample t-test. Chi-square test was used to evaluate the associations of categorical variables. Pearson correlation analysis was used to determine the relationship between maternal haemoglobin and neonatal haemoglobin concentration. P value of ≤ 0.05 was deemed statistically significant.

RESULTS

There were 75 pregnant women in the study altogether. The demographic profile revealed that the majority of the subjects were in reproductive age group (21-30 years), with a mean age of 27.4 ± 5.2 years. The majority of women were from rural backgrounds and a large percentage had low levels of education. The results show that most participants in the study were young pregnant women and with relatively low resource levels.

Table 1: Demographic Characteristics of Pregnant Women

Variable	Frequency	Percentage
Total Participants	75	100%
Age <20 Years	9	12.0%
Age 21–30 Years	46	61.3%
Age >30 Years	20	26.7%
Rural Residence	44	58.7%
Urban Residence	31	41.3%
Illiterate	28	37.3%
Primary/Middle Education	25	33.3%
Matric Or Above	22	29.4%

The obstetric and antenatal characteristics were: 46 (61.3%) of the women were multigravida, and 29 (38.7%) were primigravida. Less than half reported having regular antenatal visits. Likewise, only 32 (42.7%) women consumed iron and folic acid regularly, while 43 (57.3%) consumed either irregularly or not at all. This indicates the inadequacy of antenatal follow-up and compliance with supplements among the study participate.

Table 2: Obstetric and Supplementation Characteristics

Variable	Frequency	Percentage
Primigravida	29	38.7%
Multigravida	46	61.3%
Regular ANC Visits	34	45.3%
Irregular/No ANC Visits	41	54.7%
Regular Iron/Folic Acid Supplementation	32	42.7%
Irregular/No Supplementation	43	57.3%

Anemia in mothers was common in this study. The average maternal Hb level was 10.1 ± 1.4 g/dL. In total, 49 women were anemic and 26 (34.7%) had normal haemoglobin levels. Mild anemia was present in 23 (30.7%), moderate anemia in 20 (26.7%), and severe anemia in 6 (8.0%) participants. This suggests anemia was prevalent among pregnant women in the study population.

Table 3: Distribution of Maternal Haemoglobin Status

Maternal Hb Status	Frequency	Percentage
Normal Hb	26	34.7%
Mild Anemia	23	30.7%
Moderate Anemia	20	26.7%
Severe Anemia	6	8.0%
Total Anemic Women	49	65.3%

Deficiency in iron and folic acid were also seen. Forty-two (56.0%) of women were found to be iron deficient; 31 (41.3%) women were folic acid deficient. Twenty-four (32.0%) were found to have combined iron/folic acid deficiency. The results indicate that micronutrient deficiency was common among pregnant women and might have been associated with low levels of haemoglobin in pregnant women.

Table 4: Frequency of Iron and Folic Acid Deficiency

Deficiency Status	Frequency	Percentage
Iron Deficiency	42	56.0%
No Iron Deficiency	33	44.0%
Folic Acid Deficiency	31	41.3%
No Folic Acid Deficiency	44	58.7%
Combined Iron And Folic Acid Deficiency	24	32.0%

The mean maternal haemoglobin level was lower among women with iron deficiency compared with those without iron deficiency. The mean Hb was 9.4 ± 1.1 g/dL for women with iron deficiency and 11.0 ± 1.2 g/dL for women without iron deficiency. The difference between these was statistically significant ($p < 0.001$). Similarly, folic acid-deficient women had lower maternal Hb levels compared with women having normal folate status (9.6 ± 1.2 g/dL vs. 10.8 ± 1.3 g/dL, $p = 0.002$).

Table 5: Association of Iron and Folic Acid Deficiency with Maternal Haemoglobin

Maternal Deficiency Status	Maternal Hb G/Dl Mean ± SD	P-Value
Iron Deficiency Present	9.4 ± 1.1	<0.001
Iron Deficiency Absent	11.0 ± 1.2	
Folic Acid Deficiency Present	9.6 ± 1.2	0.002
Folic Acid Deficiency Absent	10.8 ± 1.3	

Neonatal haemoglobin was also affected by maternal micronutrient status. The mean haemoglobin concentration in the neonates was 14.7 ± 1.6 g/dL. The haemoglobin values of neonates born to iron deficient mothers were significantly lower than those of neonates whose mothers were not iron deficient (13.9 ± 1.4 g/dL vs. 15.6 ± 1.3 g/dL; p < 0.001). They also found that neonates of folate deficient mothers had lower haemoglobin levels (14.1 ± 1.5 g/dL vs. 15.2 ± 1.4 g/dL, p = 0.004) than neonates of mothers with normal folate status.

Table 6: Association of Maternal Deficiency Status with Neonatal Haemoglobin

Maternal Deficiency Status	Neonatal Hb G/Dl Mean ± SD	P-Value
Iron Deficiency Present	13.9 ± 1.4	<0.001
Iron Deficiency Absent	15.6 ± 1.3	
Folic Acid Deficiency Present	14.1 ± 1.5	0.004
Folic Acid Deficiency Absent	15.2 ± 1.4	

Of the neonatal outcome measurements, 21 (28.0%) newborns had low haemoglobin levels, and 54 (72.0%) had normal haemoglobin levels. 19 neonates (25.3%) were weighed under 5.5 lb at birth and 11 neonates (14.7%) were admitted to the NICU. The results indicate that there might be a relationship between low maternal haemoglobin and micronutrient levels and adverse neonatal haematological and birth outcomes.

Table 7: Neonatal Outcomes

Neonatal Outcome	Frequency	Percentage
Normal Neonatal Hb	54	72.0%
Low Neonatal Hb	21	28.0%
Normal Birth Weight	56	74.7%
Low Birth Weight	19	25.3%
NICU Admission	11	14.7%

A weak positive correlation was observed between maternal with neonatal haemoglobin. A positive correlation was seen between the increase in maternal haemoglobin and the improvement in neonatal haemoglobin by using Pearson correlation analysis. This relationship was statistically significant (r = 0.58, p < 0.001), indicating that there is an important relationship between maternal haemoglobin concentration and neonatal haemoglobin concentration.

Table 8: Correlation between Maternal and Neonatal Haemoglobin

Variables Compared	Correlation Coefficient	P-Value
Maternal Hb and Neonatal Hb	R = 0.58	<0.001

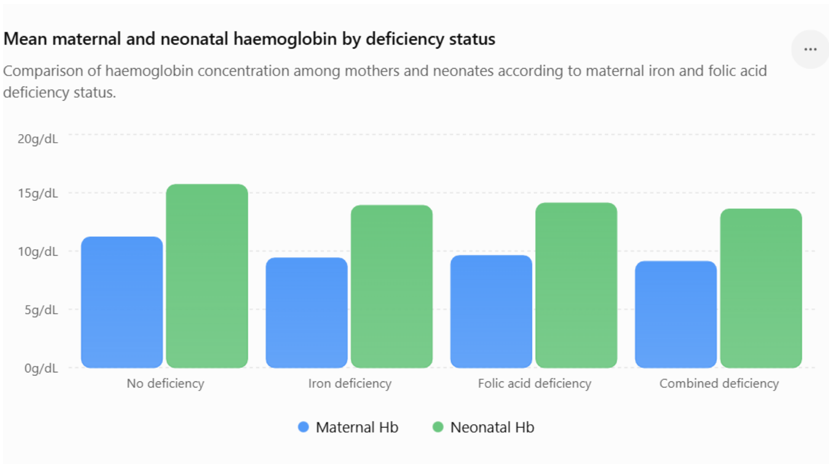

Figure 1: Mean Maternal and Neonatal Haemoglobin Concentration According to Maternal Iron and Folic Acid Deficiency Status.

The figure shows that maternal and neonatal haemoglobin levels were highest among participants without deficiency and lowest among those with combined iron and folic acid deficiency. This indicates that maternal micronutrient deficiency during pregnancy is associated with reduced haemoglobin concentration in both mothers and neonates.

DISCUSSION

The present study assessed maternal iron and folic acid deficiency during pregnancy and its relationship with maternal and neonatal haemoglobin concentration. In this study, maternal anemia was observed in 49 (65.3%) pregnant women, while iron deficiency and folic acid deficiency were found in 42 (56.0%) and 31 (41.3%) women, respectively. These findings show that anemia and micronutrient deficiency were common among pregnant women in the study population. This may be due to poor dietary intake, low socioeconomic status, inadequate antenatal care visits, increased nutritional requirement during pregnancy, and irregular use of iron and folic acid supplementation (13, 14).

In this study, the mean concentration of maternal haemoglobin was 10.1 ± 1.4 g/dL. The haemoglobin level was significantly lower for women with iron deficiency than for women without iron deficiency. This discovery lends weight to the importance of iron in the production of haemoglobin. The iron requirement rises during pregnancy due to: expansion of maternal blood volume, fetal growth, placental development, and maternal blood loss at delivery. If this extra requirement is not met via diet or supplements, the iron stores are depleted and maternal haemoglobin falls. Thus, iron deficiency is one of the leading causes for anemia among pregnant women (15-17).

The relationship of folic acid deficiency with lower haemoglobin concentration in mothers was also significant. In this study, the mean haemoglobin level was found to be lower in women with FAD than in women with normal folate status. Folic acid is used to make red blood cells and DNA. Folic acid deficiency in pregnant women can lead to impaired erythropoiesis and thus maternal anemia. The presence of both iron and folic acid deficiency in 24 (32.0%) women also suggests that anemia in pregnancy often occurs as a result of multiple nutritional deficiencies (18).

Similarly, in this study, neonatal haemoglobin (Hb) concentration was influenced by the status of maternal deficiencies. The mean haemoglobin levels in neonates born to iron deficient mothers were significantly lower than those of neonates of mothers who were not iron deficient. Likewise, the haemoglobin levels in the neonates of folate deficient mothers were found to be lower than the haemoglobin levels in the neonates of mothers with normal folate concentration. These results indicate that nutrition of mother during pregnancy is a crucial determinant of the neonatal hematological status. Low maternal iron and folate reserves can be a constraint on the supply of iron and folate to the fetus, and may also play a role in low haemoglobin concentration at birth (19).

There was a moderate positive correlation found between maternal haemoglobin and neonatal haemoglobin concentration. The better the haemoglobin of the mothers, the greater was the chance that their neonates would have better neonatal haemoglobin concentration. This study underscores the need to prevent and correct maternal anemia during pregnancy. Early detection and intervention regarding maternal anemia might have a positive impact on maternal and fetal outcomes.

In the present study, it was found that only 32 (42.7%) women used iron and folic acid on a regular basis while the rest used them irregularly or not at all. This could have been one of the reasons for high levels of maternal anemia and micronutrient deficiency. Some of the causes of poor compliance may be due to ignorance, side effects of supplements, delayed booking of antenatal bookings, inadequate counselling and limited access to antenatal care services. Thus, the improvement of antenatal counseling and regular supplementation may be helpful in reducing the burden of anemia among pregnant women (20).

Low neonatal haemoglobin was seen in 21 (28.0%) neonates, low birth weight was reported in 19 (25.3%) neonates. There are various maternal, foetal and placental factors that may affect the outcome of the newborn, but these might be important for maternal anemia and micronutrient deficiency. Good levels of iron and folic acid are needed for both the mother's health and the growth of her baby and the formation of his blood. These results underscore the importance of

early detection and correction of nutritional deficiencies in pregnancy (21).
This study has a few limitations. It was performed in one institution and involved a small number (75) of patients, so the results are not generalized to other pregnant women. History was used primarily to assess dietary intake and this may have been influenced by the recall bias. In-depth assessment of serum vitamin B12 level and other causes of anemia was not done in detail. The study does give useful local data on the correlation between maternal iron and folic acid deficiency and maternal and neonatal haemoglobin concentration, however.

CONCLUSION

Maternal iron and folic acid deficiency were common among pregnant women in this study and were significantly associated with reduced maternal haemoglobin concentration. Neonates born to mothers with iron and folic acid deficiency also had lower haemoglobin levels, showing an important relationship between maternal micronutrient status and neonatal hematological outcome. A positive correlation was found between maternal and neonatal haemoglobin concentration. Regular antenatal screening, dietary counseling, and improved compliance with iron and folic acid supplementation are recommended to reduce maternal anemia and improve neonatal haemoglobin status.

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