

Study on Haemoglobin Concentration During First Trimester of Pregnancy: Analysis with Folic Acid Supplementation

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Abstract: During pregnancy, haemoglobin concentration is an important indicator of maternal health. The first trimester is a crucial period when physiological changes, such as plasma volume expansion, can affect haemoglobin levels. Folic acid is routinely prescribed to support red blood cell formation and prevent anaemia during early pregnancy. This study was designed to evaluate the variations in haemoglobin levels during the first trimester of pregnancy and to examine the impact of folic acid supplementation. A paired-sample design was adopted to compare haemoglobin levels at the beginning and end of the first trimester among 50 pregnant women who were receiving folic acid supplementation. The mean, standard deviation, and t-values were calculated, and statistical significance was tested using the paired t-test. The mean haemoglobin concentration at the beginning of the first trimester was 11.63 g/dl, which reduced to 11.32 g/dl by the end of the trimester. The mean change of 0.31 g/dl was found to be statistically significant ($t = 2.87$, $df = 49$, $p < 0.01$), indicating a significant decline in haemoglobin concentration despite folic acid supplementation. The study finally concludes that there is a significant reduction in haemoglobin concentration during the first trimester of pregnancy, even with regular folic acid intake. This suggests that during early gestational period, folic acid alone may not be sufficient to maintain haemoglobin levels. Combined supplementation of iron and folic acid, along with regular haemoglobin monitoring and adequate nutrition, is recommended to prevent anaemia and ensure better maternal and fetal health outcomes.

Keywords: Haemoglobin, Pregnancy, Folic acid supplementation, First trimester, Anaemia

1. Introduction

Anaemia refers to a condition in which the blood has a diminished ability to transport oxygen due to decreased levels of haemoglobin. Haemoglobin levels are affected by the intake of micronutrients such as iron, vitamin B12, and folate [1]. Folate supplementation is commonly advised for pregnant women who have iron deficiency anaemia, regardless of their serum folate concentration. In pregnancy, anaemia is diagnosed when haemoglobin levels fall below 11 g/dL, Mild anaemia ranges from 10.0 to 10.9 g/dL, moderate anaemia from 7.0 to 9.9 g/dL, and severe anaemia is indicated when haemoglobin levels drop below 7.0 g/dL. Among non-pregnant women of reproductive age, anaemia is defined as a haemoglobin level of less than 12 g/dL [2].

Folic acid (vitamin B9) plays a vital role in forming heme, the iron-containing pigment that makes up part of haemoglobin in red blood cells. Insufficient folic acid intake disrupts the proper development and maturation of red blood cells, leading to anaemia. Folic acid represents the synthetic version of folate, which is a water-soluble B-vitamin and the natural form of vitamin B9. It is essential for producing red and white blood cells, converting carbohydrates into energy, and maintaining overall cellular growth and function. During pregnancy, both folate and folic acid are crucial as they help lower the risk of neural tube defects, including spina bifida [3]. Worldwide, it is advised that women consume an additional 400 micrograms of folic acid daily, beginning before conception and continuing through at least the first

trimester of pregnancy [4].

Iron and folic acid deficiencies are frequently observed among young individuals aged 15 to 49 years, as well as in pregnant women [5]. Hence, the World Health Organization (WHO) recommends daily oral supplementation of iron and folic acid to reduce the risk of anaemia and to prevent fetal developmental abnormalities in young women (World Health Organization, 2018) [6]. During human pregnancy, the absorption of iron by the mother is significantly reduced in the first trimester. Studies on animal models have also shown that iron can act as a teratogen during a similar stage of embryonic development. Therefore, the supplementation of iron tablets is not possible during first trimester. Most of the iron transfer to the fetus occurs during the third trimester [7].

Folic acid functions in coordination with vitamin B12 to support the production of red blood cells and to ensure proper utilization of iron in the body [8]. The aim of this study was to analyze an increase in haemoglobin concentration after intake of folic acid supplements during first trimester of pregnancy using RBC morphology and treatment response as a tool.

2. Materials and Methods

This prospective cohort study was carried out to evaluate an increase in haemoglobin concentration after intake of folic acid supplements during first trimester of pregnancy. The research was conducted over a span of 10 months in the

Department Obstetrics and Gynecology at Little Flower Hospital and Research Centre, Angamaly. Pregnant women reporting antenatal clinic using folic acid supplements for a minimum of 1 month continuously during first trimester of pregnancy will be included in the study after obtaining a written consent. Here, a daily dose of 400mcg folic acid is routinely given to pregnant women. Participants were chosen through purposive sampling, and the minimum required sample size was determined to be 50.

Eligibility criteria included pregnant women reporting antenatal clinic using folic acid supplements for a minimum of 1 month continuously during first trimester of pregnancy. Pregnant women use folic acid supplements continuously before 1-3 months of pregnancy, Pregnant women using iron supplements during first trimester of pregnancy, Pregnant women with any complications related to blood loss especially bleeding during first trimester of pregnancy were excluded from this study.

Data collection involved obtaining written informed consent. Clinical details will be collected using specially designed proforma. Preprocedural data will be collected from obstetrics department and follow up information was obtained at the conclusion of the first trimester of pregnancy. Ethical clearance was granted by the Institutional Ethics Committee, and participant confidentiality was ensured throughout the study. The haemoglobin concentration of participants will be collected during first antenatal check-up. At the end of first trimester, the haemoglobin concentration of participants again will be collected. The data were entered into a excel sheet and subjected to statistical comparison between the haemoglobin concentrations at the beginning and end of the first trimester of pregnancy.

The collected data were entered into statistical software and analyzed using IBM SPSS (Statistical Package for the Social Sciences) version 22. The Kolmogorov-Smirnov test was applied to determine the normality of the dataset. t test is used for comparisons of pre-test and post-test values.

3. Data Collection

The data collection procedure was carefully organized to maintain accuracy and completeness. Following approval from the ethics committee, participants who met the inclusion criteria were selected, and written informed consent was obtained. Data were recorded using a structured proforma, which documented haemoglobin levels at both the beginning and the end of the first trimester of pregnancy.

4. Results

4.1 Haemoglobin Concentration during first antenatal checkup

The descriptive statistics of the haemoglobin concentration during first antenatal checkup are presented in Table 2. The mean haemoglobin levels among the study participants were 11.63 g/dL with a standard deviation of 1.06, indicating the majority of pregnant women had haemoglobin concentration close to the normal range. The minimum haemoglobin concentration observed was 8.9 g/dL, which indicates

moderate anaemia as per WHO classification. The maximum haemoglobin concentration was 13g/dL, which is within the normal physiological range for pregnancy.

Table 2: Haemoglobin Concentration during first antenatal checkup

Mean	SD	Minimum	Maximum
11.63	1.06	8.9	13

The table 3 and the figure 1 shows the haemoglobin concentration among women during their first antenatal checkup. Out of a total of 50 participants, 40 women (80%) had normal haemoglobin levels, indicating that the majority had adequate iron status. Mild anaemia was observed in 6 women (12%), while 4 women (8%) had moderate anaemia. No cases of severe anaemia were reported. This suggests that although most of the women maintained normal haemoglobin levels, a small proportion (20%) showed varying degrees of anaemia. Therefore, regular monitoring of haemoglobin levels, along with appropriate nutritional counselling and iron supplementation, is essential to prevent the progression of anaemia and to ensure better maternal health outcomes during pregnancy.

Table 3: Haemoglobin Concentration during first antenatal checkup

Hb level	Frequency	Percentage
Normal	40	80%
Mild	6	12%
Moderate	4	8%
Severe	0	0%

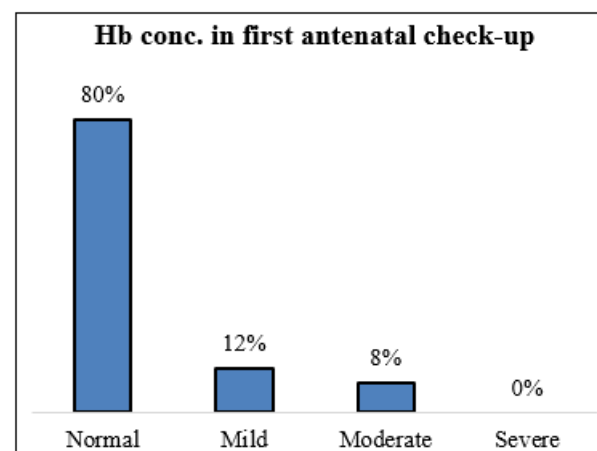


Figure 1: Haemoglobin Concentration during first antenatal checkup

4.2 Haemoglobin Concentration at the end of first trimester

The descriptive statistics of haemoglobin concentration at the end of first trimester reveal a mean score of 11.32 g/dL with a standard deviation of 1.05, indicating a moderate variation among the study subjects. The haemoglobin values ranged from 9.2 g/dl to 13 g/dl. This suggests that while most women-maintained haemoglobin levels within the acceptable range for pregnancy, a few exhibited mild anaemia (Hb < 11 g/dl). The average value being slightly below the normal non-pregnant range reflects the expected physiological haemodilution that occurs during pregnancy. Overall, the findings indicate that the majority of the participants had

adequate haemoglobin concentration at the end of the first trimester.

Table 4: Haemoglobin Concentration at the end of first trimester

Mean	SD	Minimum	Maximum
11.32	1.05	9.2	13

From the table 5 and the figure 2 it can be seen, the haemoglobin concentration at the end of first trimester. It was observed that 66% of the women had normal haemoglobin levels, indicating adequate iron status during early pregnancy. 22% of the participants were found to have mild anaemia, while 12% exhibited moderate anaemia. Notably, no cases of severe anaemia were reported in this group. This distribution suggests that although the majority of women maintained normal haemoglobin concentration, a significant proportion experienced some degree of anaemia during early pregnancy.

Table 5: Haemoglobin Concentration at the end of first trimester

Hb Level	Frequency	Percentage %
Normal	33	66%
Mild	11	22%
Moderate	6	12%
Severe	0	0%

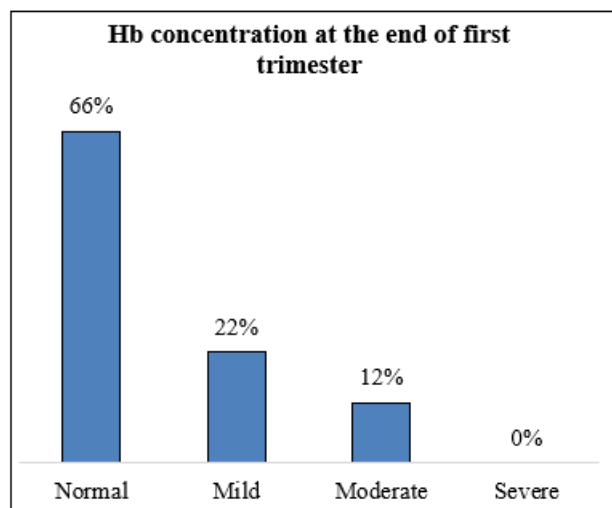


Figure 2: Haemoglobin Concentration at the end of first trimester

4.3 Comparison of haemoglobin concentration at the beginning and end of first trimester of pregnancy

The table 6 presents a comparison of haemoglobin (Hb) concentration among pregnant women at the beginning and end of the first trimester to evaluate changes during this period. The mean haemoglobin concentration at the beginning of the first trimester was 11.63 g/dl with a standard deviation of 1.06, whereas at the end of the trimester, it decreased slightly to 11.32 g/dl with a standard deviation of 1.05. The mean change in haemoglobin level was 0.31 g/dl.

Table 5: Mean, S.D. and t value to assess the changes in haemoglobin concentration

Hb	Mean	S.D.	Mean change	t	df	Significance (p-value)
Beginning	11.63	1.06	0.31	2.87	49	$p < 0.01^*$
End of 1 st trimester	11.32	1.05				

The Mean column in the paired-samples t test table shows the mean Hb level at the beginning and end of first trimester of pregnancy. The Standard Deviation column shows the standard deviation of the scores. Mean change column is the difference between the mean Hb at the beginning and end of the first trimester of pregnancy in the study (11.63 g/dl & 11.32 g/dl). Since the significance (p-value) is less than 0.01, we can find that the change in Hb, 0.31 is significant.

5. Discussion

This study assessed the haemoglobin concentration among pregnant women during the first trimester and evaluated the impact of folic acid supplementation on haemoglobin levels. The findings revealed a mean haemoglobin value of 11.63 g/dl at the beginning of the first trimester, which decreased to 11.32 g/dl by the end of the trimester. The mean change in haemoglobin level was 0.31 g/dl, with t-value of 2.87 and p-value < 0.01 , shows that the reduction in haemoglobin concentration was statistically significant.

This result suggests that, despite folic acid supplementation, there was a mild but significant decline in haemoglobin levels during early pregnancy. The decrease can be attributed to the physiological haemodilution that occurs as plasma volume expands more rapidly than red cell mass during pregnancy. This is a normal adaptation process meant to enhance uteroplacental blood flow, but it can lead to apparent reductions in haemoglobin concentration.

Folic acid supplementation is known to play a key role in erythropoiesis and prevention of megaloblastic anaemia. However, the findings indicate that supplementation alone may not completely prevent the fall in haemoglobin during the first trimester. This suggests that, although folic acid contributes to maintaining normal red cell production, other factors such as iron intake, nutritional status, and pre-pregnancy haemoglobin levels may influence overall haemoglobin concentration.

Similar results have been reported in previous studies also, where a decline in haemoglobin concentration during early pregnancy was observed despite routine folic acid intake. These studies also emphasize the importance of combined folic acid and iron supplementation for optimal maternal hematological health.

In summary, this study demonstrates a statistically significant reduction in haemoglobin levels during the first trimester of pregnancy. The findings highlight the necessity of continuous monitoring of haemoglobin concentration and ensuring adequate iron along with folic acid supplementation to prevent early gestational anaemia and promote maternal wellbeing.

6. Conclusion

This study was undertaken to evaluate the changes in haemoglobin concentration during the first trimester of pregnancy and to assess the impact of folic acid supplementation on maintaining the normal haemoglobin levels. The analysis revealed that the mean haemoglobin level at the beginning of pregnancy was 11.63 g/dl, that reduced to 11.32 g/dl by the end of the first trimester. The observed mean change of 0.31 g/dl was found to be statistically significant ($p < 0.01$), indicating that a considerable decrease in haemoglobin concentration occurred during this period despite routine folic acid supplementation.

This decline in haemoglobin level can be attributed to physiological haemodilution, a natural adaptation during pregnancy where plasma volume expands more rapidly than red cell mass. As a result, even though the total haemoglobin content remains stable or increases slightly, its concentration in the blood appears reduced. While folic acid plays a vital role in red blood cell formation and prevention of megaloblastic anaemia, the findings of this study suggest that folic acid supplementation alone may not be sufficient to prevent the early fall in haemoglobin levels.

The results emphasize the need for comprehensive antenatal nutritional support, including both iron and folic acid supplementation, to meet the increased physiological demands of pregnancy. In conclusion, although folic acid supplementation contributes to maintaining healthy formation of blood, it does not entirely prevent the reduction in haemoglobin concentration during early pregnancy. Mainly, folic acid is important in pregnancy to prevent neural tube defects like spina bifida and anencephaly. Therefore, a combined approach involving iron, folic acid, and adequate nutrition is essential to support maternal health and to reduce the risk of anaemia-related complications throughout pregnancy.

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