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Original Research Article

Anemia profiling in antenatal women at a tertiary care center in northern India: An observational study

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ABSTRACT

Background: Anemia is a common health issue during pregnancy, with various factors influencing its occurrence. Iron deficiency often leads to iron deficiency anemia (IDA), significantly impacting maternal and fetal health.
Objective: This study aims to investigate the complete blood count and nutritional status, including serum iron profile, vitamin B12, and folate levels in antenatal patients.
Materials and Methods: The study involved 160 participants, predominantly from rural areas. The severity of anemia among the participants was classified according to WHO guidelines.
Results: Iron deficiency was observed in 33.75% of women, folate deficiency in 20%, and vitamin B12 deficiency in 11.25%. Some women exhibited a combination of deficiencies. The average hemoglobin level was found to be 8.69 g/dL, and the mean iron level was 35.95 μg/dL. The average ferritin levels were observed to be 49.65 ng/mL. Lastly, the Vitamin B12 and folate levels averaged at 130.21 pg/mL and 14.76 ng/mL respectively.
Conclusion: These findings provide valuable insights into the nutritional status of pregnant women and highlight the need for targeted interventions to address micronutrient deficiencies during pregnancy.

1. Introduction

Anemia, a health concern of global proportions, is notably prevalent during pregnancy. This condition, influenced by geographical location, socioeconomic status, and dietary habits, can lead to unfavorable outcomes for both the mother and the baby.[1]

Iron deficiency, often seen during pregnancy, results in iron deficiency anemia (IDA). This condition significantly impacts maternal and fetal health and can lead to complications such as intrauterine growth retardation and preterm birth.[2,3]

While it is suggested that iron deficiency in pregnant women could result in their babies having deficient iron status, more evidence is needed to confirm this.[4] Some research indicates that the fetus obtains iron independently from the mother, potentially leading to a state of deficiency.[5] Serum ferritin (SF), a reliable indicator of the body's iron stores, can predict IDA if measured in early pregnancy.[6]

Anemia can also be influenced by serum folate and vitamin B12 levels.[7] These typically decrease to around half of the non-pregnant levels during pregnancy due to factors such as hemodilution, altered renal functions, and hormonal changes.[8,9] As pregnancy progresses, maternal folate metabolism increases due to rapid cell proliferation, leading to a turnover of up to 400g/day in the third trimester. Short interpregnancy (intervals were categorized as less than

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6 months, 6-11 months, and 12-17 months) can exacerbate maternal folate deficiency, resulting in adverse outcomes in subsequent pregnancies.[10]

Vitamin B12 deficiency is common among women who follow a strict vegetarian diet for an extended period.[11] It is more prevalent in women and infants in several developing countries.[12] This study aims to examine the complete blood count and nutritional status profile, including serum iron profile, vitamin B12, and folate levels in antenatal patients.

2. Materials and Methods

2.1. Participant recruitment

The research was carried out in collaboration between the Department of Obstetrics and Gynecology and the Department of Biochemistry at Dr Ram Manohar Lohia Institute of Medical Sciences, Lucknow. We included 160 pregnant women who were diagnosed with anemia during their antenatal OPD visits. The classification of anemia followed the WHO guidelines, categorizing the women into Mild anemia (Hb: 9-11g/dl), Moderate anemia (Hb: 7-9g/dl), and Severe anemia (Hb: <7g/dl).[13]

2.2. Sample acquisition

Blood samples were collected in two types of vials - plain and EDTA. The EDTA vials were used for complete blood count (CBC) analysis, while the plain vials were used for assessing iron profile, cyanocobalamins (Vit -B12) and folic acid (Vit B-6) levels.

2.3. Estimation of CBC and Vitamin B9 and B12

The CBC was determined using the Abbott Alinity automated system, which provides a 6-part White Blood Cell (WBC) differential along with several other parameters using Advanced MAPSS technology. Serum folate and vitamin B12 levels were measured using an automated immune fluorescence assay method. Serum iron, Unsaturated Iron Binding Capacity (UIBC), and Serum Ferritin were assessed by the ferrozine method using an automated biochemical analyzer (Beckman Coulter AU-480). Total Iron Binding Capacity (TIBC) was calculated using the formula: Iron + UIBC.

2.4. Data analysis

Data representation was done in terms of numbers and percentages, mean and standard deviation. The data analysis was performed using SPSS version 21 (IBM, Chicago, US). p-value < 0.05 considered as significant.

3. Results

3.1. Study population characteristics

The study involved a total of 160 participants, with ages ranging from 18 to 31 years and an average age of 26.03±5.87 years. The participants were predominantly from rural areas (55%) compared to urban areas (45%). In terms of dietary habits, a majority of the participants were vegetarians (57.5%), while the rest were non-vegetarians (42.5%). The religious distribution of the participants was fairly balanced with 58.7% identifying as Hindu and 41.3% as Muslim. More than half of the participants were literate (55.6%), while the rest were illiterate (44.4%).

The severity of anemia among the participants, classified according to WHO guidelines, revealed that 54.4% had mild anemia, 40.6% had moderate anemia, and 5% had severe anemia. When classified morphologically, 52.5% of the participants exhibited microcytic hypochromic cells, 24.4% had normocytic normochromic cells, and 23.2% displayed macrocytic cells (Table 1).

Table 1: Demographic and clinical characteristics of the study population

Variables	N (%) N= 160
Age	
(Range:18 – 31 years)	26.03±5.87
Locality	
Urban	72(45.0)
Rural	88(55.0)
Diet	
Vegetarian	92(57.5)
Non-vegetarian	68(42.5)
Religious	
Hindu	94(58.7)
Muslim	66(41.3)
Education	
Literate	89(55.6)
Illiterate	71(44.4)
Severity of Anaemia (WHO guideline)	
Mild (9-11g/dl) (Grade 1)	87(54.4)
Moderate (7-9g/dl) (Grade 2)	65(40.6)
Severe (<7g/dl) (Grade 3)	8(5.0)
Morphological Classification	
Microcytic Hypochromic	84(52.5)
Normocytic Normochromic	39(24.4)
Macrocytic	37(23.2)

3.2. Prevalence and co-occurrence of iron, folate, and vitamin B12 deficiencies among women

The study revealed various nutritional deficiencies among the participants (Table 2). Iron deficiency was identified in 33.7% of the participants (54 individuals), while folate deficiency was found in 20% of the participants (32 individuals). Vitamin B12 deficiency was less common,

affecting 11.2% of the participants (18 individuals). Interestingly, some participants exhibited multiple deficiencies. A combination of iron, Vitamin B12, and folate deficiency was found in 16.3% of the participants (26 individuals), while a combined deficiency of Vitamin B12 and folate was observed in 18.8% of the participants (30 individuals).

Table 2: Classification of anemic cases on the basis of etiology

Variables	Number	Percentage (%)
Iron deficiency	54	33.7
Folate deficiency	32	20.0
Vit B12 deficiency	18	11.2
Iron +Vit B12+Folate deficiency	26	16.3
Vit B12+Folate deficiency	30	18.8

3.3. Analysis of complete blood count and nutritional parameters in the study population

Complete Blood Count (CBC) parameters, the average hemoglobin levels were found to be 8.69 g/dL, while the red and white blood cell counts averaged at 3.38 million/mm3 and 11.76 x 10^9/L respectively. The platelet count was observed to be 207.57 x 10^9/L on average. The Mean Corpuscular Volume (MCV), Mean Corpuscular Hemoglobin (MCH), Mean Corpuscular Hemoglobin Concentration (MCHC), and Red Cell Distribution Width (RDW) averaged at 88.23 fL, 27.46 pg, 31.08 g/dL, and 18.75% respectively.

As for the nutritional parameters, the average iron levels were found to be 35.95 μg/dL. The Unsaturated Iron Binding Capacity (UIBC) and Total Iron Binding Capacity (TIBC) averaged at 256.44 μg/dL and 314.21 μg/dL respectively. The average ferritin levels were observed to be 49.65 ng/mL. Lastly, the Vitamin B12 and folate levels averaged at 130.21 pg/mL and 14.76 ng/mL respectively (Table 3).

3.4. Correlation between Hb, Iron, and Ferritin

Figure 1 evident that the hemoglobin showed a positive correlation with iron (r=0.394, p<0.0001), and a negative correlation with ferritin (r=-0.303, p<0.0001). Other parameters did not shown a correlation (Table 4).

4. Discussion

This study delved into the exploration of hemoglobin concentration, iron, ferritin, vitamin B12, and folate levels in the serum of anemic pregnant women. The results revealed that a significant number of pregnant women were categorized under mild anemia, with iron deficiency being the primary cause of anemia during pregnancy. Our findings resonate with previous research in several ways. A study

Table 3: Status of complete blood counts and nutritional parameters in the study population

Variables	Mean±SD
CBC	
Hemoglobin (g/dL)	8.69±2.94
Red blood cells (million/mm3)	3.38±1.59
White blood cells (10^9/L)	11.76±6.54
Platelets (10^9/L)	207.57±176.05
Mean Corpuscular Volume (fL)	88.23±13.06
Mean Corpuscular Hemoglobin (pg)	27.46±5.42
Mean Corpuscular Hemoglobin Concentration (g/dL)	31.08±2.73
Red Cell Distribution Width (%)	18.75±4.76
Nutritional Parameters	
Iron (μg/dL)	35.95±21.55
Unsaturated Iron Binding Capacity (μg/dL)	256.44±124.44
Total Iron Binding Capacity (μg/dL)	314.21±107.70
Ferritin (ng/mL)	49.65±10.70
Vitamin B12 (pg/mL)	130.21±107.70
Folate (ng/mL)	14.76±2.56

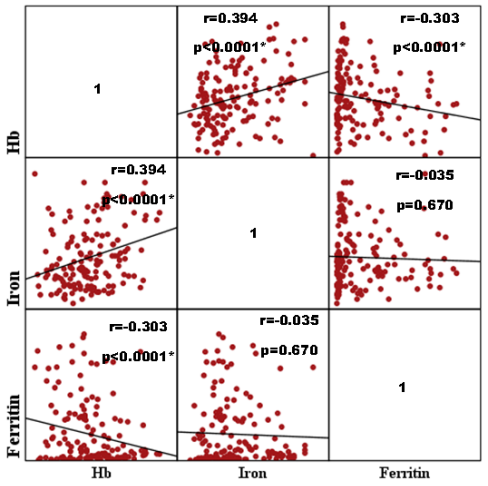

Figure 1: Pearson correlation between hemoglobin, iron and ferritin

involving 1,684 pregnant women across 42 communities in Bali identified the duration of pregnancy, level of education, and use of antenatal iron tablets as the most common risk factors for anemia during pregnancy.[14] Given the high incidence of iron deficiency anemia among pregnant women in Bali, preventive strategies such as food iron fortification, iron supplementation, and health education were advocated. Another study underscored that national surveys reported a prevalence of 63.5% in 1990 and 51.4% in 1995.[15] The majority of these cases were mild anemia - a common finding in field surveys. Even mild anemia can have a detrimental effect on fetal and maternal health. A retrospective observational study by Reva et al., involving

Table 4: Correlation oHb with iron, ferritin, vitamin B12 and folic acid

Variables	Hb	Iron	Ferritin	Vitamin B12	Folic acid
Hb	1	r=0.394 p<0.0001*	r=-0.303 p<0.0001*	r=-0.201 p=0.013*	r=-0.119 p=0.144
Iron		1	r=-0.035 p=0.670	r=-0.074 p=0.364	r=0.026 p=0.743
Ferritin			1	r=0.343 p<0.0001*	r=0.229 p=0.004*
Vitamin B12				1	r=0.123 p=0.131
Folic acid					1

Pearson correlation coefficient analysis was used to see the correlation between two variables.
*p<0.05 was considered as statistically significant.

185 pregnant women with severe anemia, found that iron-deficiency anemia is still the most significant cause of anemia.[16] They also noted a high prevalence of macrocytic anemia among these cases of severe anemia in pregnancy. Maternal and fetal morbidity and mortality rates are higher in macrocytic anemia compared to iron-deficiency anemia. A similar pattern was reported in a study conducted in Venezuela where up to 36.32% and 61.34% of pregnant women were deficient in folate and B12 respectively.[17] This study also addressed the issue of macrocytic anemia in pregnancy. In this study, the overall prevalence of severe anemia was 1.2%, with macrocytic anemia present in 41.6% of patients. Schorah et al. also reported increasing evidence that deficient vitamin B12 levels are associated with pregnancy-related problems like neural tube defects and anencephaly.[18] There are some limitations to this study which can be addressed in future research such as ensuring the sample size is large enough to be representative of the population, and ensuring that time constraints do not limit the duration of the study. Selection bias could have led to a non-random sample, and confounding variables that were not measured or controlled for could influence the outcome. These potential limitations should be considered when interpreting the findings and conclusions of this study.

5. Conclusion

This study provides valuable insights into the prevalence of anemia and micronutrient deficiencies among pregnant women. The findings reveal that mild anemia is most common, with iron deficiency being the predominant cause. The study also highlights the influence of factors such as length of gestation, level of education, and antenatal iron tablet use on anemia during pregnancy. Furthermore, the study underscores the need for preventive strategies such as food iron fortification, iron supplementation, and health education. Despite some limitations, these findings contribute significantly to our understanding of anemia during pregnancy and pave the way for future research in this area. It is hoped that these insights will inform targeted interventions to address micronutrient deficiencies during pregnancy and improve maternal and fetal health outcomes.

6. Source of Funding

None.

7. Conflict of Interest

None.

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