DOI: 10.7860/JCDR/2026/82275.23302

Original Article

Obstetrics and Gynaecology Section

Assessment of Iron Stores among Non Anaemic Pregnant Women in their First Trimester: A Cross-sectional Study

MD MOHSIN[1], PALASH MAZUMDER[2], SHYAMALI DUTTA[3], ALKA KUMARI[4], NEEPABITHI MITRA[5], SUKUMAR MITRA[6]

ABSTRACT

Introduction: During the first trimester of pregnancy, iron stores begin to deplete without any apparent signs of Iron Deficiency Anaemia (IDA). This gradual depletion can result in ineffective erythropoiesis, eventually leading to anaemia in the second and third trimesters. In India, where most pregnancies are unplanned, assessing iron stores during the preconception period is particularly challenging.

Aim: To determine the prevalence of depleted iron stores among non anaemic pregnant women in their first trimester.

Material and Methods: A cross-sectional study was carried out in the Department of Obstetrics and Gynaecology, Medical College, Kolkata, West Bengal, India, from April 2021 to March 2022. A total of 150 pregnant women in their first trimester, attending the Outpatient Department (OPD) and having haemoglobin levels ≥11 g/dL and Packed Cell Volume (PCV) ≥33%, were enrolled. Data were collected and analysed based on variables such as age, socioeconomic status, parity, haemoglobin levels, PCV, Mean Corpuscular Volume (MCV), Mean Corpuscular Haemoglobin Concentration (MCHC), serum iron, serum ferritin, and Total Iron Binding Capacity (TIBC). Standard statistical methods were used for data analysis. Numerical variables were presented as mean±Standard Deviation (SD), and categorical variables were expressed as counts and percentages. A p-value of <0.05 was considered statistically significant.

Results: The mean age of subjects was 24.63±4.88 years (range: 17-39 years; median: 24 years). The mean haemoglobin was 11.97±0.75 g/dL, while the mean PCV was 37.08±2.82%, mean MCV was 84.30±5.15 fL, and mean MCHC was 32.66±1.61. Among the total participants, 66 women (44%) had serum iron and ferritin levels below the normal range, indicating iron deficiency despite being non anaemic. Whereas for TIBC, 84 women (56%) had normal levels, and 66 (44%) had elevated TIBC. A statistically significant positive correlation was observed between serum ferritin and serum iron (p<0.0001), while a statistically significant negative correlation was found between TIBC and serum iron (p<0.0001).

Conclusion: The study found that a significant proportion of non anaemic pregnant women in the first trimester had depleted iron stores.

Keywords: Anaemia, Ferritin, Haemoglobin, Ineffective erythropoiesis, Iron, Pregnancy

INTRODUCTION

Iron Deficiency Anaemia (IDA) is the most prevalent nutritional disorder encountered during pregnancy, particularly in low- and middle-income countries like India, where its prevalence ranges from 68.8% to 96.8% [1]. IDA significantly contributes to adverse maternal and fetal outcomes, including preterm labour, pre-eclampsia, cardiac failure, low birth weight, intrauterine fetal death, and increased perinatal mortality [1,2]. Moreover, neonates born to anaemic mothers are at risk of long-term cognitive and behavioural impairments, persisting even after iron correction [2].

Pregnancy imposes an increased iron demand due to expanding maternal blood volume and fetal development needs. The plasma volume rises by approximately 40%, surpassing the 20% increase in red cell mass, resulting in physiological haemodilution [3,4]. This, coupled with limited pre-pregnancy iron stores, predisposes expectant mothers to IDA [5,6].

While IDA has been extensively studied, growing evidence suggests that iron deficiency can occur without anaemia, known as Non Anaemic Iron Deficiency (NAID) [7]. NAID is particularly relevant in pregnancy, as iron requirements escalate early to support maternal haemopoiesis, placental growth, and organogenesis [8].

Iron depletion often begins silently in the first trimester and may only progress to anaemia in later stages, especially in the absence of supplementation [3,5,6]. Since many pregnancies in India are unplanned, assessing iron stores before conception remains challenging [9].

Although tests such as serum ferritin, TIBC, and transferrin saturation offer insights into iron status, these are not routinely performed [10]. The National Family Health Survey-5 (2019-21) reports anaemia in 57% of pregnant Indian women [11]. This likely underestimates the true burden of iron deficiency, given the reliance on haemoglobin alone for screening. A substantial proportion of pregnant women may have depleted iron stores without manifesting anaemia in the early stages of pregnancy [5].

In India, IDA remains a leading contributor to maternal mortality, driven by dietary inadequacies, infections, haemoglobinopathies, and socioeconomic factors. The first trimester is a critical window for fetal development, and subclinical iron deficiency during this phase may elevate risks of preterm birth, low birth weight, and neurodevelopmental impairments [12]. Additionally, iron deficiency-even without anaemia can lead to maternal fatigue, reduced productivity, and increased susceptibility to infection [13].

Given this context, the primary objective of the current study was to assess the prevalence of depleted iron stores among non anaemic pregnant women in their first trimester so that early detection and timely correction of iron deficiency can be done as a preventive measure against IDA in pregnancy. The secondary objective was to correlate between different iron parameters.

MATERIALS AND METHODS

This cross-sectional study was conducted in the Department of Obstetrics and Gynaecology, Medical College Kolkata, West

Bengal, India, from April 2021 to March 2022. The study population comprised pregnant women in their first trimester attending the OPD of Obstetrics and Gynaecology at Medical College Kolkata. The study commenced after receiving approval from the Institutional Ethics Committee (Ref No. MC/KOL/IEC/NON-SPON/900/01/21 dated 15/01/21) and adhered to standard ethical guidelines. Informed consent was obtained from all participants in Bengali, English, or Hindi using a pre-approved consent form.

Inclusion criteria: Pregnant women in the first trimester with haemoglobin ≥11 g/dL and PCV ≥33% were included.

Exclusion criteria: Pregnant women with known haemoglobinopathies and with prior history of blood transfusion and iron supplementation were excluded from this study.

Sample size calculation: Based on findings from a previous study by Auerbach M et al., the sample size was calculated using the formula [14]:

$n=4PQ/L^2$, where P=42%, Q=1-P=58%, and L=20% of 42.

(n=sample size, P=estimated prevalence, Q=complement of P, calculated as 1-P, L=permissible error).

The calculated sample size was 138, and to account for non responders, 12 additional participants were included, making the final sample size 150. Purposive sampling was employed.

Study Procedure

Demographic and clinical variables such as age, socioeconomic status (assessed using the Modified Kuppuswamy scale) [15], gravida, PCV, MCV, MCHC, serum iron, serum ferritin, and TIBC were recorded for all participants.

Serum iron markers were evaluated with support from the Department of Biochemistry. Serum ferritin levels were quantified by chemiluminescent immunoassay, while serum iron was measured by the ferriczyme endpoint method and TIBC by the latex turbidimetric endpoint method.

STATISTICAL ANALYSIS

Data were analysed using Statistical Package for the Social Sciences (SPSS) software (version 28.0) and GraphPad Prism (version 5). Results were summarised using mean and SD for numerical variables and frequencies and percentages for categorical variables. Correlation was calculated by Pearson correlation analysis. A p-value of <0.05 was considered statistically significant.

RESULTS

The study enrolled 150 non anaemic pregnant women in their first trimester. The mean age of participants was 24.63±4.88 years, with 34 (22.7%) participants aged below 20 years, 95 (63.3%) between 21 and 30 years, and 21 (14.0%) between 31 and 40 years. A previous history of anaemia was reported in 26 participants (17.3%) [Table/Fig-1].

Haematological parameters showed a mean haemoglobin of 11.97±0.75 g/dL, mean PCV of 37.08±2.82%, mean MCV of 84.30±5.15 fL, and mean MCHC of 32.66±1.61 g/dL [Table/Fig-2]. These parameters exhibited symmetrical distributions with median Z-scores near zero. While MCV and MCHC values remained within normal variability (Z-scores within ±2), isolated high outliers were noted for haemoglobin (+2.71) and PCV (+3.51); however, no exclusion or sensitivity analysis was performed as these values remained within clinically acceptable limits.

The mean serum iron was 69.05±35.38 mcg/dL, mean serum ferritin 86.71±65.05 ng/mL, and mean TIBC 433.61±109.78 mcg/dL [Table/Fig-3]. Z score analysis showed symmetrical distributions with occasional high outliers for serum iron (+2.00), serum ferritin (+2.43), and TIBC (+2.83).

For TIBC, 84 (56%) had normal levels (250-450 mcg/dL), and 66 (44%) had elevated TIBC (>450 mcg/dL) [Table/Fig-4]. Serum iron showed a strong positive correlation with serum ferritin (r=0.703, p<0.0001) and a strong negative correlation with TIBC (r=-0.693, p<0.0001), both statistically significant at p<0.01 [Table/Fig-5].

Variables	Category	n (%)
Age (years)	<20	34 (22.7)
	21-30	95 (63.3)
	31-40	21 (14.0)
	Mean±SD	24.63±4.88
Socioeconomic status	Low	25 (16.67)
	Lower middle	118 (78.67)
	Upper middle	7 (4.66)
	High	0
Gravida	1	66 (44.0)
	2	49 (32.7)
	3	21 (14.0)
	4	14 (9.3)
Anaemia (relevant past history)	No	124 (82.7)
	Yes	26 (17.3)

[Table/Fig-1]: Distribution of study participants by age, socioeconomic status, gravida and relevant past history of anaemia (N=150).

Parameters	Number	Mean±SD	Minimum	Maximum	Median	Median Z score
Hb (g/dL)	150	11.97±0.75	11.00	14.00	12.00	+0.04
PCV (%)	150	37.08±2.82	33.00	47.00	36.15	-0.33
MCV (Fl)	150	84.30±5.15	77.00	93.00	84.40	+0.02
MCHC (gm/dL)	150	32.65±1.61	30.00	35.00	32.50	-0.09

[Table/Fig-2]: Descriptive statistics of haematological parameters (N=150).

DISCUSSION

The present study showed that a significant proportion of participants exhibited biochemical markers of iron deficiency, highlighting the presence of subclinical iron depletion during early pregnancy.

A considerable proportion (44%) were primigravida, which is slightly higher than the 37.7% reported by a larger cohort study (n=793) where gravida 1 participants comprised 37.7% (95% CI: 34.3-41.1) of the sample [16].

Notably, although participants were non anaemic based on haemoglobin values, 44% had low serum iron and 44% had low serum ferritin levels. These findings are similar to a study by Auerbach M et al., who showed 42% of non anaemic women in the first trimester of pregnancy were iron-deficient [14]. Ohsuga T et al., also found similar results - 41.9% NAID in early trimester [17].

Balendran S and Forsyth C observed low ferritin and low transferrin saturation in presence of normal haemoglobin level [18]. Hansen R et al., studied a cohort of 5763 singleton pregnant women, of which 14.2% had NAID, and 1.2% had IDA [19]. These studies indicate that a huge burden of iron deficiency is not reflected by haemoglobin level alone.

These findings highlight the potential benefit of biochemical iron status assessment even in non anaemic pregnant women, especially in low- and middle-income countries where dietary iron intake may be insufficient. Future large-scale, multicentric studies with longitudinal follow-up are recommended to validate these findings and guide early iron supplementation strategies in non anaemic pregnant women.

Limitation(s)

In this present study, limitations were its single-center design, the absence of dietary and socioeconomic variable assessment beyond baseline, and the lack of follow-up to evaluate the progression of anaemia or pregnancy outcomes.

Parameters	Number	Mean±SD	Minimum	Maximum	Median	Median z score
Serum iron (mcg/dL)	150	69.0480±35.3755	28.6000	140.0000	57.0000	-0.34
Serum ferritin (ng/mL)	150	86.7127±65.0468	19.3000	245.1000	66.5500	-0.31
TIBC (mcg/dL)	150	433.6067±109.7821	258.0000	745.0000	417.0000	-0.15

[Table/Fig-3]: Distribution of mean serum iron, serum ferritin and TIBC levels (N=150).

Parameters	Category	n (%)
Serum iron (mcg/dL)	Abnormal <40	66 (44.0)
	Normal 40-140	84 (56.0)
	Total	150 (100.0)
Serum ferritin (ng/mL)	Abnormal <30	66 (44.0)
	Normal 30-250	84 (56.0)
	Total	150 (100.0)
TIBC (mcg/dL)	Normal 250-450	84 (56.0)
	Abnormal >450	66 (44.0)
	Total	150 (100.0)

[Table/Fig-4]: Distribution of participants based on serum iron, serum ferritin, and TIBC levels (N=150).

Haematological parameters	Pearson's Correlation Coefficient (r)	p-value
Haemoglobin (gm%)	-0.049	0.551
PCV (%)	-0.013	0.877
MCV (Fl)	0.048	0.558
MCHC (gm/dL)	-0.066	0.421
Serum Ferritin (ng/mL)	0.703	<0.0001
TIBC (mcg/dL)	-0.693	<0.0001

[Table/Fig-5]: Correlation of serum iron with various haematological parameters (N=150).

CONCLUSION(S)

The present study reveals a significant presence of subclinical iron deficiency among non anaemic pregnant women in their first trimester. Nearly half of the participants had biochemical evidence of iron depletion despite having normal haemoglobin levels. Integration of biochemical screening for iron status into routine antenatal care, along with community-level preventive strategies, should be prioritised.

Acknowledgement

Authors express their sincere gratitude to the Department of Obstetrics and Gynaecology, Medical College Kolkata, for providing the necessary support to carry out the present study. Authors are deeply thankful to all the participants who volunteered their time and cooperation. They are also grateful to the Institutional Ethics Committee for their timely review and approval of the study protocol.

REFERENCES

[1] Sharma JB. Textbook of Obstetrics: Medical disorders during pregnancy. Second edition. Avichal pub-lishing Company, 2020.

[2] Breymann C, Auerbach M. Iron deficiency in gynecology and obstetrics: Clinical implications and management. Hematology Am Soc Hematol Educ Program. 2017;2017(1):152-59. Doi: 10.1182/asheducation-2017.1.152. PMID: 29222250; PMCID: PMC6142528.

[3] Bothwell TH. Iron requirements in pregnancy and strategies to meet them. Am J Clin Nutr. 2000;72(1 Suppl):257S-264S. Doi: 10.1093/ajcn/72.1.257S. PMID: 10871591.

[4] Hytten FE, Paintin DB. Increase in plasma volume during normal pregnancy. J Obstet Gynaecol Br Emp. 1963;70:402-07. Doi: 10.1111/j.1471-0528.1963.tb04922.x. PMID: 13956023.

[5] Milman N. Iron and pregnancy: A delicate balance. Ann Hematol. 2006;85(9):559-65.

[6] Allen LH. Anemia and iron deficiency: Effects on pregnancy outcome. Am J Clin Nutr. 2000;71(5 Suppl):1280S-1284S.

[7] Pavord S, Daru J, Prasannan N, Robinson S, Stanworth S, Girling J; BSH Committee. UK guidelines on the management of iron deficiency in pregnancy. Br J Haematol. 2020;188(6):819-30. Doi: 10.1111/bjh.16221. Epub 2019 Oct 2. PMID: 31578718.

[8] Means RT. Iron deficiency and iron deficiency anemia: Implications and impact in pregnancy, fetal development, and early childhood parameters. Nutrients. 2020;12(2):447. Doi: 10.3390/nu12020447. PMID: 32053933; PMCID: PMC7071168.

[9] Balarajan Y, Ramakrishnan U, Ozaltin E, Shankar AH, Subramanian SV. Anaemia in low-income and middle-income countries. Lancet. 2011;378(9809):2123-35. Doi: 10.1016/S0140-6736(10)62304-5. Epub 2011 Aug 1. PMID: 21813172.

[10] Cook JD. Diagnosis and management of iron-deficiency anaemia. Best Pract Res Clin Haematol. 2005;18(2):319-32. Doi: 10.1016/j.beha.2004.08.022. PMID: 15737893.

[11] National Family Health Survey (NFHS-5), 2019-21: India Fact Sheet. Ministry of Health and Family Welfare, Government of India.

[12] Georgieff MK. Iron deficiency in pregnancy. Am J Obstet Gynecol. 2020;223(4):516-24.

[13] Beard JL. Iron biology in immune function, muscle metabolism and neuronal functioning. J Nutr. 2001;131(2S-2):568S-579S.

[14] Auerbach M, Abernathy J, Juul S, Short V, Derman R. Prevalence of iron deficiency in first trimester, nonanemic pregnant women. J Matern Fetal Neonatal Med. 2021;34(6):1002-05. Doi: 10.1080/14767058.2019.1619690. Epub 2019 Jun 3. PMID: 31154873.

[15] Saleem S, Jan SS. Modified Kuppuswamy socioeconomic scale updated for the year 2021. Indian Journal of Forensic and Community Medicine. 2021;8:01-03. Doi: 10.18231/j.ijfcm.2021.001.

[16] Ka M, Venkatesh U, Kapoor R. Clinico-epidemiological profile of women with high-risk pregnancy utilizing antenatal services in a rural primary health center in India. J Rural Med. 2023;18(1):15-20. Doi: 10.2185/jrm.2022-018. Epub 2023 Jan 6. PMID: 36700125; PMCID: PMC9832307.

[17] Ohsuga T, Egawa M, Kii M, Ikeda Y, Ueda A, Chigusa Y, et al. Association between non-anemic iron deficiency in early pregnancy and perinatal mental health: A retrospective pilot study. J Obstet Gynaecol Res. 2022;48(11):2730-37. Doi: 10.1111/jog.15397. Epub 2022 Aug 20. PMID: 36054581.

[18] Balendran S, Forsyth C. Non-anaemic iron deficiency. Aust Prescr. 2021;44(6):193-96. Doi: 10.18773/austprescr.2021.052. Epub 2021 Dec 1. PMID: 35002031; PMCID: PMC8671013.

[19] Hansen R, Spangmose AL, Sommer VM, Holm C, Jørgensen FS, Krebs L, et al. Maternal first trimester iron status and its association with obstetric and perinatal outcomes. Arch Gynecol Obstet. 2022;306(4):1359-71. Doi: 10.1007/s00404-022-06401-x. Epub 2022 Jan 28. PMID: 35088196.

PARTICULARS OF CONTRIBUTORS:

1. Senior Resident, Department of Obstetrics and Gynaecology, Kaliyaganj SGH, Kaliyaganj, West Bengal, India.
2. Associate Professor, Department of Obstetrics and Gynaecology, Deben Mahata Government Medical College, Purulia, West Bengal, India.
3. Associate Professor, Department of Obstetrics and Gynaecology, Medical College, Kolkata, West Bengal, India.
4. Senior Resident, Department of Obstetrics and Gynaecology, Jhargram Government Medical College and Hospital, Jhargram, West Bengal, India.
5. House Staff, Department of Paeditric Surgery, NRS Medical College, Kolkata, West Bengal, India.
6. Professor, Department of Obstetrics and Gynaecology, NRS Medical College, Kolkata, West Bengal, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Shyamali Dutta,
Akshara Lotus Garden, Block 3, Flat 1A. F/F2, Hatiara Road, P.O. Aswininagar, P.S. Baguiati, Landmark LG Service Centre, Kolkata-700159, West Bengal, India.
E-mail: drsdutta23@gmail.com

PLAGIARISM CHECKING METHODS: [Jain H et al.]

- Plagiarism X-checker: Aug 26, 2025
- Manual Googling: Dec 12, 2025
- iThenticate Software: Dec 15, 2025 (2%)

ETYMOLOGY: Author Origin

EMENDATIONS: 6

AUTHOR DECLARATION:

- Financial or Other Competing Interests: None
- Was Ethics Committee Approval obtained for this study? Yes
- Was informed consent obtained from the subjects involved in the study? Yes
- For any images presented appropriate consent has been obtained from the subjects. NA

Date of Submission: **Jul 25, 2025**
Date of Peer Review: **Nov 10, 2025**
Date of Acceptance: **Dec 19, 2025**
Date of Publishing: **May 01, 2026**