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ASSOCIATION OF MATERNAL SERUM FERRITIN WITH NEWBORN OUTCOMES AMONG ANTENATAL WOMEN AT A TERTIARY CARE HOSPITAL

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ABSTRACT:
Background: Maternal iron status is critical to fetal development. While nutritional iron deficiency anemia remains a major focus in maternal public health, emerging evidence suggests that elevated serum ferritin acting either as a marker of iron excess or an acute-phase reactant, may paradoxically be linked to adverse pregnancy outcomes, including spontaneous preterm labor.
Objectives: To evaluate the association between maternal serum ferritin concentration at the time of delivery and immediate newborn outcomes (birth weight and gestational age) among antenatal mothers at a tertiary care hospital in Kakinada.
Methods: A cross-sectional study was conducted from April to December 2025 involving 208 antenatal mothers admitted for safe institutional delivery. High-risk maternal conditions altering iron metabolism or baseline inflammation (e.g., thalassemia traits, gestational diabetes, pregnancy-induced hypertension, HIV, HBsAg, antepartum hemorrhage, and severe systemic infections) were excluded. Data was collected by semi-structured questionnaires and pre-delivery serum ferritin estimation was done. Analysis was performed utilizing SPSS v26 using descriptive statistics, Chi-square test, and Pearson correlation coefficients.
Results: The study presented a high baseline prevalence of anemia (63.5%). Low serum ferritin (<15 ng/ml) was seen in 45.2% of participants, normal levels (15–150 ng/ml) in 51.9%, and high levels (>150 ng/ml) in 2.9% (Mean: 31.4 + 53.4ng/ml). Low birth weight (LBW) occurred in 12.0% of deliveries but no statistically significant association with their baseline ferritin levels ($p > 0.05$). However, preterm birth (8.2%) was significantly higher among mothers presenting with elevated serum ferritin ($p< 0.05$). A notable negative correlation was verified between gestational age and serum ferritin ($p < 0.05$).
Conclusion: Elevated maternal serum ferritin at delivery is significantly associated with shortened gestational age and preterm delivery. Role of Ferritin as an inflammatory biomarker highlights its clinical utility in risk-stratifying adverse neonatal outcomes beyond standard hemoglobin screening.

KEYWORDS: Maternal Ferritin, Preterm delivery, Low Birth Weight, Anemia in Pregnancy.

INTRODUCTION

Iron requirements escalate dramatically during pregnancy to accommodate placental development, fetal growth, and expansion of the maternal red cell mass [1]. Consequently, public health strategies traditionally focus on eradicating iron deficiency anemia (IDA) through routine iron supplementation [2]. While the dangers of depleted iron reserves are well-documented, the clinical significance of elevated maternal iron stores specifically serum ferritin concentrations remain poorly understood, particularly within South Asian populations where anemia prevalence is high [3].
Serum ferritin is the primary intracellular protein storing iron and serves as a standard clinical marker for total body iron reserves [4]. However, interpreting ferritin levels in late pregnancy is complex. Ferritin is an acute-phase reactant; its synthesis is highly upregulated by pro-inflammatory cytokines, including interleukin-6 (IL-6) and tumor necrosis factor-alpha (TNF-alpha) [5]. In the third trimester, elevated ferritin can signal a state of systemic maternal inflammation or occult intrauterine infection rather than nutritional iron adequacy [6].
Emerging epidemiological evidence suggests a paradoxical, U-shaped risk curve, where both abnormally depleted and excessively high maternal ferritin levels are linked to adverse perinatal outcomes [7]. High maternal ferritin concentrations have been associated with increased rates of gestational diabetes, pre-eclampsia, and spontaneous preterm labor [8]. This association may stem from cellular oxidative stress induced by free iron or from subclinical inflammatory cascades that stimulate premature labor pathways [9].
Given the lack of consensus on late pregnancy ferritin thresholds and their direct impact on neonatal birth dynamics in regional cohorts, this study evaluates how maternal serum ferritin levels at delivery correlate with newborn outcomes, specifically birth weight and gestational age at a tertiary referral hospital in South India.

2. METHODOLOGY

Study Design and Setting

This institutional cross-sectional study was conducted between April and December 2025 at a tertiary care hospital located in Kakinada, Andhra Pradesh, India. The study timeline encompassed patient recruitment, laboratory testing, data aggregation, and statistical profiling.

Participant Selection and Sample Size

A total of 208 antenatal mothers admitted to the labour ward for safe institutional delivery were enrolled using convenient consecutive sampling.

Inclusion Criteria: Antenatal mothers of any parity presenting in active labour or scheduled for elective delivery at term/near-term.

Exclusion Criteria: Pre-existing maternal conditions affecting iron metabolism (e.g., thalassemia trait or disease), Gestational Diabetes Mellitus (GDM), Pregnancy Induced Hypertension (PIH) / Pre-eclampsia, confirmed infectious pathologies (HIV, HBsAg reactivity, or active severe systemic infections), History of antepartum haemorrhage (APH) during the index pregnancy were excluded:

Data Collection and Laboratory Assays

Data collection utilized a pre-tested, semi-structured questionnaire administered via face to face interviews by trained research personnel. The questionnaire captured comprehensive sociodemographic and obstetric details.

At admission, a 3 ml venous blood sample was drawn from each participant under strict aseptic conditions. Samples were centrifuged to isolate serum for biochemical analysis:

1.Hemoglobin (Hb) Estimation: Determined via automated hematology analyzers, with anemia defined as Hb < 11.0 g/dl in accordance with World Health Organization (WHO) guidelines.

2.Serum Ferritin Quantitation: Measured via chemiluminescence immunoassay (CLIA). Maternal ferritin profiles were categorized into three functional tiers:

oLow Ferritin: < 15 ng/ml (denoting depleted iron stores)

oNormal Ferritin: 15 to150 ng/ml

oHigh Ferritin: > 150 ng/ml

Neonatal Outcome Assessment

Immediately following delivery, primary newborn outcomes were documented:

- **Birth Weight:** Measured within the first hour of life using a calibrated digital neonatal scale. Low Birth Weight (LBW) was defined as a birth weight strictly less than 2500 g.
- **Gestational Age:** Calculated based on the mother's documented early first-trimester ultrasound or verified Last Menstrual Period (LMP). Preterm delivery was defined as a live birth occurring prior to 37 completed weeks of gestation.

Statistical Analysis

Data were entered into Microsoft Excel and processed using SPSS Version 26.0. Continuous variables were summarized as mean, standard deviation (SD), while categorical data were expressed as frequencies and percentages. Association between maternal biochemical parameters and categorical newborn outcomes were analyzed using Pearson's Chi-square test. The linear relationship between continuous serum ferritin values and gestational age was assessed using the Pearson correlation coefficient (r) and $p < 0.05$ was considered as statistical significance.

3. RESULTS

3.1 Sociodemographic Characteristics

The study population consisted of 208 participants, with a mean age of 23.3 + 3.7 years. The majority of mothers belonged to the 20–30 years of age (85.1%). Evaluation of marital demographics revealed a mean age at marriage was 20.3 + 3.3 years and women who married before the age of 18 was 18.3%.

Table 1: Sociodemographic Distribution of Study Participants (N=208)

Variables	Sub-Category	Frequency (n)	Percentage (%)
Maternal Age	< 20 Years	24	11.5%
	20–30 Years	177	85.1%
	> 30 Years	7	3.4%
Age at Marriage	<18 Years	38	18.3%
	18–25 Years	152	73.1%
	26–30 Years	18	8.7%
Educational status	Graduation & above	40	19.3%
	Intermediate	53	25.5%
	High School	86	41.3%
	Primary School	22	10.6%
	Illiterate	7	3.4%

Occupation	Professional / Skilled	12	5.8%
	Semi-Skilled / Unskilled	21	10.1%
	Unemployed (Homemaker)	175	84.1%
Socioeconomic Status	Upper	35	16.6
	Upper Middle	80	38.5
	Middle	59	28.4
	Lower Middle	31	14.9
	Lower	3	1.4

Literates comprised of 96.6%; with 51.9% completing high school and 44.8% achieving higher education. Homemakers accounted for 84.1% and 82.0% of participants fell within middle-class socioeconomic status (Table 1).

3.2 Maternal Obstetric and Hematological Baseline

Obstetric histories and biological markers at the time of delivery are shown in Table 2.

Table 2: Obstetric and Maternal Biomarker Profiles (N=208)

Parameter	Classification	Frequency (n)	Percentage (%)
Parity	Primigravida	96	46.2%
	Second Gravida	82	39.4%
	Multigravida	30	14.4%
Type of delivery	Normal Vaginal Delivery (NVD)	128	61.5%
	Cesarean Section (C-Section)	80	38.5%
Hemoglobin Status	Normal (>11gm/dl)	76	36.5%
	Anemic (< 11gm/dl)	132	63.5%
Serum Ferritin level	Low (< 15 ng/ml)	94	45.2%
	Normal (15-150 ng/ml)	108	51.9%
	High (> 150 ng/ml)	6	2.9%
Neonatal Birth Weight	Normal Birth Weight (>2.5kg)	183	88.0%
	Low Birth Weight (< 2.5 kg)	25	12.0%

Nearly half of the participants were primigravida (46.2%). Spontaneous normal vaginal deliveries (NVD) accounted for 61.5% of the births. Hemoglobin status revealed that 63.5% of the women were anemic at delivery. Biochemical assays for serum ferritin showed that while 51.9% maintained normal levels, 45.2% suffered from clear iron depletion and 2.9% displayed abnormally elevated configurations. The mean serum ferritin value was 31.4 + 53.4 ng/ml. Birth weight 2.5kg and above was observed in 88.0% of babies (Table 2).

3.3 Birth Outcomes and Serum Ferritin Associations

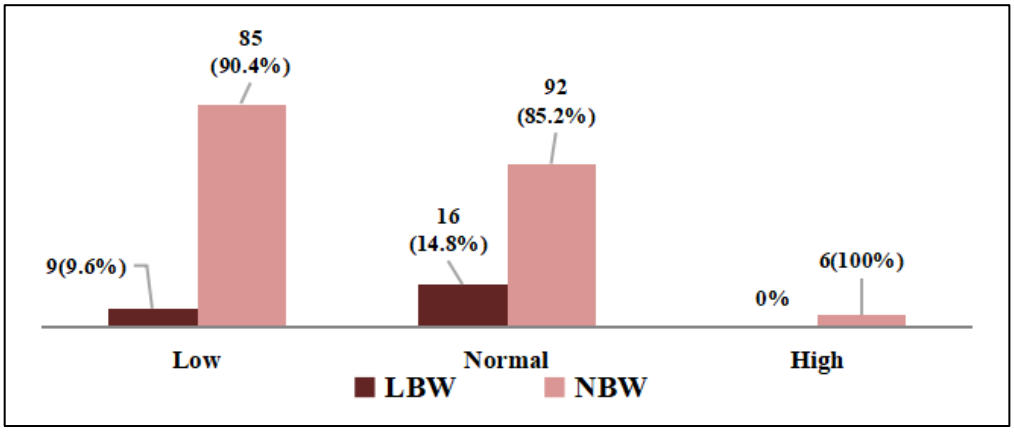

Fig 1. Distribution of Birth Weight across Serum Ferritin levels (N=208)

Irrespective of the level of Serum ferritin a higher proportion of the participants had normal birth weight. In the present study low birth weight was found to be high among those who had normal serum ferritin levels when compared with those who had low levels ($p>0.05$) (Fig:1).

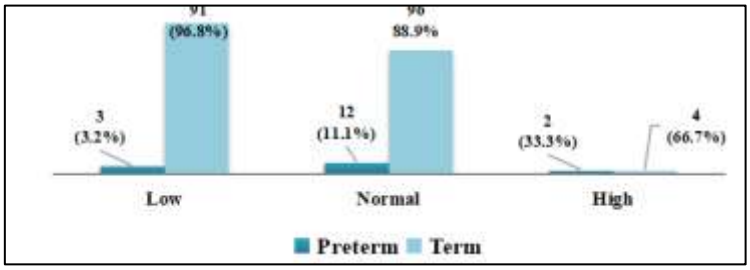

Fig 2. Distribution of Gestational Age across Serum Ferritin levels (n=208)

Irrespective of the level of Serum ferritin, a higher proportion had term deliveries. Preterm deliveries were found to be significantly high among those who had high levels of serum ferritin when compared with those who had low or normal serum ferritin levels ($p<0.05$) (Fig:2).

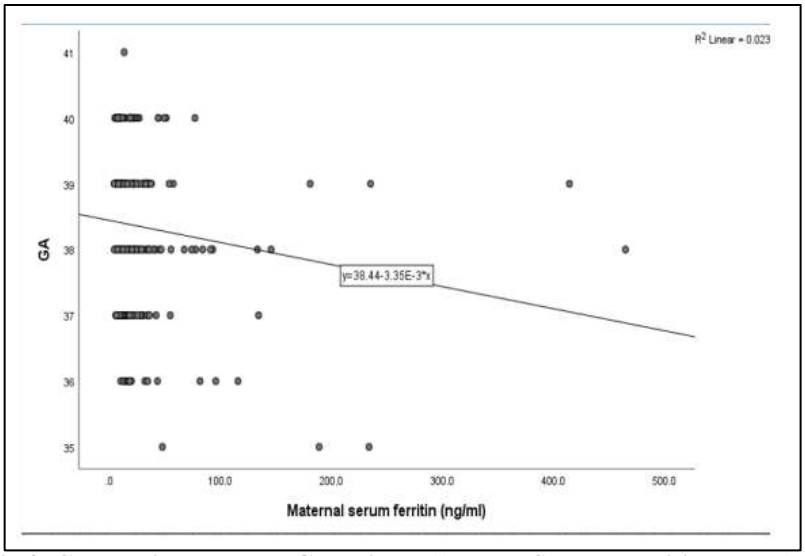

Fig 3. Correlation between Gestational Age and Serum Ferritin levels (N=208)

Negative correlation was observed between gestational age and serum ferritin levels, indicating that elevated ferritin levels were associated with pre term delivery ($r= - 0.2$, $p<0.05$) (Fig:3).

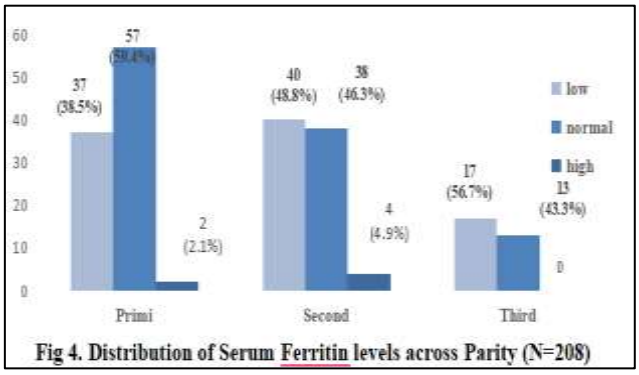

Fig 4. Distribution of Serum Ferritin levels across Parity (N=208)

Normal serum ferritin levels were found to be high among primigravida (59.4%) when compared with second (46.3%) and third gravida (43.3%). As parity is increased serum ferritin levels decreased, however no statistical significance was observed ($p>0.05$) (Fig:4).

5.DISCUSSION

This study evaluated the clinical relationship between maternal serum ferritin at delivery and neonatal outcomes. The high prevalence of anemia (63.5%) and depleted ferritin reserves (45.2%) in the present study highlights the persistent challenge of maternal iron deficiency in South Asian clinical settings, consistent with broader epidemiological data from the region [10]. The primary finding of this study is the significant association between elevated maternal serum ferritin levels (> 150 ng/mL) at delivery and preterm birth (< 37 weeks). This relationship was confirmed by a significant negative correlation ($r = -0.2$, $p < 0.05$) between ferritin levels and gestational age. This finding aligns with several large-scale

observational studies. For instance, Scholl [11] observed that elevated maternal ferritin levels in early or late pregnancy tripled the risk of preterm delivery. The biological mechanism driving this phenomenon is likely linked to ferritin's role as an acute-phase reactant. In the absence of primary iron overload conditions like hemochromatosis or hemoglobinopathies (which were excluded from this study), elevated ferritin serves as a proxy marker for subclinical infection or systemic maternal inflammation [12]. Inflammatory cytokines (such as IL-6 and TNF-alpha) induce the synthesis of both ferritin and hepcidin, restricting iron mobilization and causing ferritin to accumulate in tissues [13]. This systemic inflammatory state can trigger prostaglandin synthesis, cervical ripening, and myometrial contractility, leading to premature labor [14]. This hypothesis is supported by our observation that 3.8% of anemic mothers had elevated ferritin levels, a pattern characteristic of anemia of chronic disease or inflammation-induced iron sequestration. Regarding fetal growth, present study found no statistically significant association between maternal ferritin status and newborn birth weight ($p > 0.05$). While low maternal iron stores are traditionally associated with fetal growth restriction [15], our data showed that infants born to mothers with low ferritin did not experience significantly higher rates of low birth weight than those born to mothers with normal iron stores. This lack of significance may reflect the placenta's capacity to upregulate iron transport receptors, prioritizing fetal iron supply even when maternal stores are depleted, provided maternal anemia is not extreme [16].

6.Study Limitations and Challenges

The primary operational challenge encountered during this study was early patient discharges. Mothers admitted with false labor, or those admitted close to their expected date of delivery (EDD) who did not transition into active labor during their stay, limited long-term clinical tracking and sequential biomarker monitoring. Additionally, as a cross-sectional study, a single ferritin measurement at delivery offers limited insight into iron store dynamics across the first and second trimesters.

7.CONCLUSIONS AND RECOMMENDATIONS

While iron deficiency remains a primary maternal health concern, elevated maternal serum ferritin at delivery serves as a significant biological indicator for preterm birth risk. These findings suggest that third-trimester screening strategies should look beyond standard hemoglobin counts alone. Incorporating serum ferritin screening can help clinicians differentiate simple nutritional iron deficiency from complex, subclinical inflammatory states, allowing for more personalized antenatal care and improved neonatal risk management.

8.Declarations:

Ethics approval and consent to participate: Obtained permission from institutional ethical committee, Rangaraya medical college, Kakinada, Andhra Pradesh, India.
Consent for publication: Yes
Availability of data and materials: From the institution
Competing interests: Nil
Funding: NIL

Authors'contributions:

Dr. P. Sujatha: Conceptualization and design of the study, supervision, data collection, interpretation of findings, and critical revision of the manuscript.
Dr. G. Sridevi: Study design, data collection, statistical analysis, interpretation of data, and drafting and revision of the manuscript.
Dr. Ch. Karuna Kumari: Clinical coordination and interpretation of obstetric and neonatal outcomes.
Dr. B. Lakshmi Keerthana: Statistical analysis and interpretation of data..
All authors reviewed and approved the final version of the manuscript and agree to be accountable for all aspects of the work.

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