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Relationship of Serum Ferritin Levels with Haemoglobin Percentage and Its Impact on Fetomaternal Outcome of the Pregnancy

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ABSTRACT

Iron stores in the body exist primarily in the form of ferritin. Low serum ferritin levels, even in females with ideal haemoglobin levels, can lead to poor fetal-maternal outcome. **Objective:** To determine the frequency of low serum ferritin in non-anaemic pregnant females and its Fetomaternal outcomes. **Methods:** This Comparative analytical study was carried out in the Department of Gynaecology and Obstetrics, Fauji Foundation Hospital, Rawalpindi. Patients were enrolled from the Fauji Foundation Hospital, Rawalpindi. Detailed history was taken, and pregnant females with normal haemoglobin were selected; their serum ferritin was followed. Patients with low serum ferritin levels were observed for maternal and fetal outcomes. Data were entered and analysed by SPSS version 25.0. **Results:** The mean age of cases was 29.95 ± 3.57 years, with minimum and maximum ages of 25 and 35 years. Low serum ferritin levels were found in 248 (46.44%) cases, while in 286 (53.56%) cases serum ferritin levels were normal. 16 (21.72%) neonates were born preterm, 285 (53.37%) females had C-section, 41 (7.68%) had PPH, 96 (17.98%) neonates had low birth weight, and 94 (17.60%) neonates needed an ICU admission. Significant association of this outcome with low serum levels was found, p-value<0.001. **Conclusions:** The females with Hb levels ≥ 11g/dl should be screened for their serum ferritin levels, as females with low serum ferritin levels were associated with poor maternal outcome, like C-section, NICU admission, PPH, and poor fetal outcome, like preterm birth and low birth weight.

INTRODUCTION

During pregnancy, there is an increase in the requirement of some nutrients, like iron, to help in foetal growth and also in the physiological and metabolic changes. Iron is one of the trace metals that are important to numerous biological processes [1]. Since there is nearly a tenfold increment of iron needs during pregnancy to facilitate fetoplacental growth and the needs of the mother herself, iron deficiency anaemia (IDA) is common among pregnant women [2]. Important morbidity, including increased risks of postpartum infection, blood transfusion, and postnatal depression, premature birth, and reduced low birth weights in both the parturient and her unborn baby, may serve as the consequences of IDA [3]. Anaemia of a severe form causes ineffective compensation by the mother's body, cardiac overload, high risk of bleeding, low tolerance to blood losses, and, possibly, cardiovascular shock and death [4]. Low levels of maternal ferritin may reflect an iron deficiency that can lead to anaemia and other problems

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with pregnancy-related health [5]. Ferritin is considered a crucial biomarker and vital in supporting defence when there is bacterial invasion, since iron is one of the key elements in the growth of bacteria [6]. Whereas the levels of ferritin and haemoglobin are reflective of iron insufficiency, the levels of haemoglobin are late indicators that may not be a true reflection of tissue iron status. However, serum ferritin (SR) is, at most times, considered the most precise measure of iron deficit in pregnancy [7]. A prospective cohort study (n=412) assessed the prognosis of the connection between low birth weight (LBW) and maternal iron status in rural eastern Ethiopia. The LBW was 20.2 percent. The probability of a pregnancy delivering LBW infants was also higher by 5 times with women with IDA (serum ferritin <15 µg/L) [8]. On the same note, recent cohort evidence has shown that maternal serum ferritin levels during pregnancy are associated with adverse maternal and fetal outcomes, highlighting the importance of monitoring maternal iron status [9]. Nonetheless, another cohort study did not show any association at week 14; however, increased ferritin at week 30 was linked to 2-fold higher risks of low birth weight (OR = 2.27) and lower birth weight (−93g; p=0.021).[10] Moreover, another retrospective study identified that gestational diabetes and small for gestation age babies were associated with increased serum ferritin (SF) concentration. The levels of ferritin are to be observed and regulated, as hyper SF during pregnancy can increase the chance of having GDM and SGA [9]. These findings point out a contradiction in the literature concerning the level of serum ferritin and the Fetomaternal outcome.

Even though some studies have observed that low ferritin levels may cause such problems as preterm births, low birth weight, and the risk of caesarean delivery, other studies point out the dangers of high ferritin. This study aimed to clarify the relationship of serum ferritin levels with haemoglobin percentage and its impact on the Fetomaternal outcome of the pregnancy.

METHODS

The Comparative analytical study was carried out from June 11, 2025 to Dec 10, 2025, in the Department of Gynaecology and Obstetrics, Fauji Foundation Hospital, Rawalpindi. 534 cases of pregnant ladies. Sample size was calculated using the WHO sample size calculator, taking a confidence level 95%, an iron deficiency rate in pregnant women as 15% [11], by taking 4% margin of error, out rate after approval of the Ethical review committee (Ref No: 977/RC//FFH/RWP; dated 11th June 2025). Patients were enrolled by a non-probability consecutive technique. All pregnant women between the ages of 25-35 years with singleton pregnancy and gestational age between 27- 40 weeks admitted to the labour room for delivery with Hb levels ≥ 11g/dl. Women with comorbid conditions like pre-eclampsia/essential hypertension, diabetes/GDM, renal disease, cardiac disease, and febrile conditions. Patients with thalassemia, chronic anaemia, elderly primigravida, and those with two or more previous caesarean sections were also excluded. Patients were enrolled from the Department of Gynaecology and Obstetrics, Fauji Foundation Hospital, Rawalpindi. Detailed history was taken, and pregnant females with normal haemoglobin were selected; their serum ferritin was followed. Patients with low serum ferritin levels were observed for maternal and fetal outcome in terms of preterm birth, low birth weight, post-partum haemorrhage, caesarean section, and NICU admissions. The mode of delivery was also noted, and in the case of caesarean section, the indication was taken into account. The following definitions and clinical criteria were used in this study to assess maternal and fetal outcomes. Serum ferritin was considered low when levels were less than 15 µg/L. Haemoglobin was regarded as normal when equal to or greater than 11 g/dL. Iron deficiency was defined using a single serum ferritin cut-off value of < 15 µg/L, in accordance with World Health Organization recommendations for assessment of depleted iron stores in adult women [12]. Maternal outcomes included preterm delivery, defined as the birth of a baby before 37 completed weeks of gestation. Caesarean section was defined as the surgical delivery of the baby through an incision in the maternal abdomen and uterus, performed under spinal or general anaesthesia. Indications for caesarean section, such as fetal distress observed on cardiotocography (CTG) as a non-reactive trace, and obstructed labour, were also documented. Post-partum haemorrhage (PPH) was defined as blood loss exceeding 500 mL (for vaginal delivery) or 1000 mL (for caesarean section) within the first 24 hours following childbirth. Blood loss was clinically estimated using calibrated instruments such as a kidney tray, with one tray approximately equating to 500 mL. Fetal outcomes included low birth weight, defined as a birth weight less than 2.5 kg, and NICU admission, which referred to the admission of the newborn to the neonatal intensive care unit within the first 24 hours after birth. All the patients who met the inclusion criteria were included in the study. After preoperative assessment, informed consent was taken for inclusion in the study. Data were collected on a pre-formatted proforma, and the results were compiled.

Statistical analysis was performed using SPSS version 25.0. Quantitative variables, including age, gestational age, serum ferritin, and haemoglobin, were measured as mean ± S.D. Qualitative variables like preterm birth, caesarean section, post-partum haemorrhage, low birth weight, NICU admissions, and low serum ferritin were measured as frequency and percentage. Effect modifiers like age,

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gravidity, parity, and gestational age were controlled by stratification. Post-stratification chi-square test was applied. The p-value≤0.050 was significant.

RESULTS

The mean age of cases was 29.95 ± 3.57 years, with minimum and maximum ages of 25 and 35 years. There were 256 (47.94%) cases that were 25-29 years old, and 278 (52.06%) cases were 30-35 years of age. A total of 238 (44.57%) had < 3 Gravida, and 296 (55.43%) had Gravida ≥ 3, while 385(72.10%) cases had < 3 parity and 149 (27.90%) cases had parity ≥ 3. The average gestational age was 37.12 ± 2.47 weeks with a range of 13 weeks (27 and 40 weeks). The mean Hb of all females was 11.54 ± 0.77 with a minimum and maximum Hb of 10.25 and 14.29 mg/dl. The mean serum ferritin was 21.80 ± 15.03 with minimum and maximum values of 2 and 62, respectively (Table 1).

Table 1: Descriptive Statistics of Maternal and Clinical Variables (n=534)

Variables	Mean ± SD	Range	Minimum	Maximum
Age (years)	29.95 ± 3.57	10.00	25.00	35.00
Gestational Age (weeks)	37.12 ± 2.47	13.00	27.00	40.00
Haemoglobin (g/dL)	11.54 ± 0.77	3.04	10.25	14.29
Serum Ferritin (µg/L)	21.80 ± 15.03	60.00	2.00	62.00

According to the operational definition, low serum ferritin levels were found in 248 (46.44%) cases while in 286 (53.56%) cases serum ferritin levels were normal. According to the outcome, 116 (21.72%) neonates were born preterm, 285 (53.37%) females had C-section, 41 (7.68%) had PPH, 96 (17.98%) neonates had low birth weight, and 94 (17.60%) neonates needed an ICU admission (Figure 1).

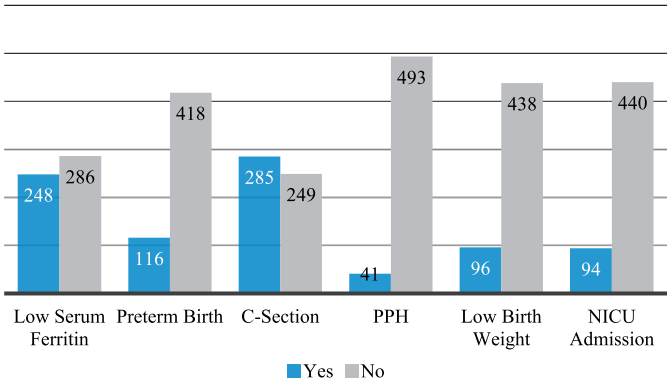

Figure 1: Distribution of Maternal and Fetal Outcomes

Women with low serum ferritin were much more likely to have anaemia (Hb <11 g/dL) than those with normal ferritin (64.5% vs. 15.7%). In contrast, women with normal ferritin mostly had healthy haemoglobin levels (84.3%). This strong, statistically significant association (p<0.001) highlights how closely a mother's iron stores are linked to her haemoglobin levels (Table 2).

Table 2: Cross-Tabulation Between Serum Ferritin Status and Haemoglobin Level

Serum Ferritin	Hb <11 g/dL	Hb ≥11 g/dL	Total	Chi-square (df)	p-value
Low (n=248)	160 (64.5%)	88 (35.5%)	248	133.6 (1)	<0.001
Normal (n=286)	45 (15.7%)	241 (84.3%)	286		
Total (n=534)	205	329	534		

The low serum ferritin was significantly associated with poor maternal and neonatal outcomes. The proportion of women with low serum ferritin had a significantly higher preterm birth (75.0% vs. 25.0%, p<0.001), caesarean section (54.0% vs. 46.0%, p<0.001), and postpartum haemorrhage (90.2% vs. 9.8%, p < 0.0001) than those with normal levels of serum ferritin. Equally, low birth weight (88.5% vs. 11.5% p<0.001) and NICU admission (71.3% vs. 28.7% p<0.001) were also significantly higher among the neonates of mothers with low serum ferritin. All the observed relationships were very significant, suggesting a strong correlation between maternal iron deficiency and the risk of poor obstetric and neonatal outcomes. The findings indicate that low levels of maternal ferritin can be a significant predictor of complications in pregnancy (Table 3).

Table 3: Comparison of Low Serum Levels with Respect to Outcome

Low Serum Ferritin	Preterm Birth		C-section		PPH		Low Birth Weight		NICU Admission	
	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Yes	96 (75.0%)	152 (37.4%)	154 (54.0%)	94 (37.8%)	37 (90.2%)	211 (42.8%)	85 (88.5%)	163 (37.2%)	67 (71.3%)	181 (41.1%)
No	32 (25.0%)	254 (62.6%)	131 (46.0%)	155 (62.2%)	4 (9.8%)	282 (57.2%)	11 (11.5%)	275 (62.8%)	27 (28.7%)	259 (58.9%)
Chi-square (df) p-value	111.2 (1), 0.001		34.7 (1), 0.001		80.6 (1), 0.001		120.4 (1), 0.001		52.8 (1), 0.001	

Low serum ferritin was more frequent among women aged 25-29 years than among women aged 30-35 years (58.5% vs. 41.5, p<0.001) and was also significantly related to gestational age <37 weeks (38.7% vs. 11.2, p<0.001). The preterm birth was not greatly correlated with maternal age (p=0.770), but, predictively, preterm birth only happened in the pregnancies below 37 weeks (p<0.001). There was no significant relationship between age and gestational age with caesarean section and postpartum haemorrhage (p>0.050). Conversely, low birth weight and NICU admission were frequent with pregnancies that were below 37 weeks (p<0.001 and p=0.001, respectively), and there was no significant association with maternal age. On the whole, gestational age less than 37 weeks played a major factor in unfavourable types of neonatal outcome (Table 4).

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Table 4: Comparison of Maternal and Fetal Outcomes by Different Strata

Outcomes	Sub-category	Yes, n (%)	No, n (%)	χ^2	df	p-value
Low Serum Ferritin	Age 25-29	145 (58.5%)	111 (38.8%)	38.2	1	<0.001
	Age 30-35	103 (41.5%)	175 (61.2%)			
	GA <37 Weeks	96 (38.7%)	32 (11.2%)	49.1	1	<0.001
	GA ≥37 Weeks	152 (61.3%)	254 (88.8%)			
Preterm Birth	Age 25-29	57 (49.1%)	199 (47.6%)	0.09	1	0.770
	Age 30-35	59 (50.9%)	219 (52.4%)			
	GA <37 Weeks	116 (100%)	0 (0%)	534	1	<0.001
	GA ≥37 Weeks	0 (0%)	406 (100%)			
C-Section	Age 25-29	139 (48.8%)	117 (47.0%)	0.16	1	0.681
	Age 30-35	146 (51.2%)	132 (53.0%)			
	GA <37 Weeks	63 (22.1%)	65 (26.1%)	1.16	1	0.280
	GA ≥37 Weeks	222 (77.9%)	184 (73.9%)			
Postpartum Hemorrhage (PPH)	Age 25-29	22 (53.7%)	234 (47.5%)	0.58	1	0.446
	Age 30-35	19 (46.3%)	259 (52.5%)			
	GA <37 Weeks	6 (14.6%)	122 (24.7%)	2.08	1	0.145
	GA ≥37 Weeks	35 (85.4%)	371 (75.3%)			
Low Birth Weight	Age 25-29	47 (49.0%)	209 (47.7%)	0.04	1	0.852
	Age 30-35	49 (51.0%)	229 (52.3%)			
	GA <37 Weeks	53 (55.2%)	75 (17.1%)	87.1	1	0.001
	GA ≥37 Weeks	43 (44.8%)	363 (82.9%)			
NICU Admission	Age 25-29	45 (47.9%)	211 (48.0%)	0.0001	1	0.998
	Age 30-35	49 (52.1%)	229 (52.0%)			
	GA <37 Weeks	48 (51.1%)	80 (18.2%)	45.2	1	0.001
	GA ≥37 Weeks	46 (48.9%)	360 (81.8%)			

DISCUSSION

Gestational anaemia may be typically due to depleted iron stores of depleted reserves or poor dietary intake. Pregnant women have a daily iron requirement of around 45mg of iron, relative to 12mg in non-pregnant women, and are therefore especially prone to iron deficiency. The main storage protein of iron is serum ferritin, and it is the most sensitive biomarker to identify iron deficiency during pregnancy and is increasingly used in preference to haemoglobin alone, which only indicates iron deficiency in later stages [13]. The median maternal age of our cohort was 29.95 with SD 3.57, with more than half (52) of the cohort aged between 30 and 35 years. This is in line with other researchers, including Thaichana *et al.* who have indicated that advanced maternal age can be a risk factor on its own, in increasing the chances of obstetric complications, including preterm birth and caesarean section [14]. The majority of the subjects were multiparous and multigravida (≥3), which is in agreement with the published literature that indicated an increasing parity to be the major cause of cumulative iron depletion leading to anaemia of iron deficiency [15]. The current study found the mean gestational age (37.12 ± 2.47 weeks), mean haemoglobin (12.43 ± 0.77 g/dl), and this lies in the lower normal range. The mean serum ferritin was, however, 21.80 15.03 ng/mL, and 46.44 percent of the respondents were found to possess low ferritin, meaning that most of the women were iron deficient despite not having anaemia. It has been found that local studies reported similar findings; e.g., a study by Khan *et al.* determined that maternal iron deficiency played a significant role in preterm birth [16], and a different study by local researchers indicated that 33 percent of women who had low ferritin levels delivered low-weight children [17]. These associations are also reinforced by regional studies conducted in Asia, which focus on the fact that maternal ferritin deficiency is a strong predictor of poor perinatal outcomes [18, 19]. These findings are supported by systematic reviews and meta-analyses conducted worldwide. The pooled analysis of 38 studies (that consist of more than 31 million pregnant women) found that anaemia was linked with increased incidence of intrauterine growth restriction by 30% (OR = 1.30, 95% CI 1.051.62) [20]. The future studies have also indicated trimester-specific relationships with high haemoglobin in early to mid-pregnancy related to gestational diabetes and PIH, and low haemoglobin and ferritin in late pregnancy to preterm birth and PROM [5]. These results highlight the significance of early diagnosis as well as trimester-specific observation. WHO recommends that serum ferritin levels less than 15ng/mL during the first trimester and less than 30ng/mL during the second and third trimesters present iron deficiency [21]. Even though our study used one cut-off of 15 µg/L across all gestational ages, current findings support the clinical significance of even moderately low levels of ferritin, which were also linked with severe maternal and child risks. The main intervention is the iron supplementation, although oral iron is recommended in mild cases and intravenous iron is used in the severe or unresponsive cases [22]. Concluding on this, it is possible to note that the current results underline the necessity to implement proactive ferritin-based screening and individual iron supplementation in pregnancy to minimize the premature burden of preventable adverse outcomes.

This research is characterized by some limitations. The study was a single centre, and it is possible that the results could not be applied to a general population. The sample size was somewhat small, and this might interfere with the degree of association between serum ferritin and Fetomaternal outcomes. Moreover, we used one time point of serum ferritin, and this may not completely show iron status during pregnancy. Also, the possible confounding factors were not controlled, including iron supplementation, inter-pregnancy intervals, maternal BMI, socioeconomic status, and overall nutritional status, which might have had an independent impact on ferritin levels as well as on maternal or neonatal outcomes. Conditions of inflammation, which may increase ferritin, were not always

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excluded. Lastly, there is no possibility of a causal relationship since it is an observational study.

CONCLUSIONS

The females with Hb levels ≥ 11g/dl should be screened for their serum ferritin levels, as females with low serum ferritin levels have poor maternal outcomes, such as C-section, NICU admission, PPH, and poor fetal outcomes like preterm birth and low birth weight. Despite the strong association between low maternal serum ferritin and adverse maternal and neonatal outcomes, the descriptive case series design does not allow for establishing a causal relationship.

Authors' Contribution

Conceptualization: NS
Methodology: ASA, TF, UQ
Formal analysis: ASA, MA
Writing and Drafting: NS, TF, UQ, SK
Review and Editing: NS, ASA, TF, UQ, SK, MA

All authors approved the final manuscript and take responsibility for the integrity of the work

Conflicts of Interest

All the authors declare no conflict of interest.

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