



Original Article

Maternal Serum Ferritin and Subsequent Gestational Diabetes Mellitus: A Prospective Observational Study at a Tertiary Care Centre in Rajasthan

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ABSTRACT

Background: Elevated maternal serum ferritin may reflect iron stores as well as metabolic inflammation. We examined its association with subsequent gestational diabetes mellitus (GDM).

Objectives: To assess the relationship between baseline ferritin categories and the occurrence of GDM during pregnancy.

Methods: In this prospective observational study from a tertiary care centre in Ajmer, 251 pregnant women underwent ferritin testing by chemiluminescence immunoassay. Ferritin values were grouped as <30, 30–49, 50–69 and ≥70 ng/mL. GDM was assessed with the Diabetes in Pregnancy Study Group India 75-g glucose test. Associations were evaluated using chi-square testing and unadjusted odds ratios.

Results: GDM was recorded in 43 women (17.1%). Across increasing ferritin categories, GDM occurred in 7.1%, 10.0%, 17.9% and 34.5% of participants ($\chi^2=18.77$; $p<0.001$). Ferritin ≥70 ng/mL was associated with higher unadjusted odds of GDM than ferritin <30 ng/mL (OR 6.84; 95% CI 2.16–21.66). Women older than 25 years also had increased odds (OR 3.91; 95% CI 1.95–7.87).

Conclusions: Higher serum ferritin was associated with greater GDM occurrence. Ferritin requires further validation as an adjunctive risk marker and cannot replace glucose-based testing.

Keywords: serum ferritin; gestational diabetes mellitus; pregnancy; iron status; prospective observational study.

INTRODUCTION

Gestational diabetes mellitus (GDM) is a common metabolic complication of pregnancy associated with maternal hypertensive disorders, operative delivery and adverse neonatal outcomes.^{1,2} A systematic review of Indian studies estimated its pooled prevalence at approximately 13%, with substantial variation across regions and diagnostic criteria.³ Identifying women at increased risk before routine mid-pregnancy glucose screening remains an important objective of antenatal care.

Pregnancy is characterised by a progressive reduction in insulin sensitivity. GDM develops when compensatory pancreatic beta-cell activity fails to meet the increased insulin demand.⁴ Changes in iron handling may contribute to metabolic dysregulation through oxidative stress, inflammatory pathways and altered insulin signalling. Serum ferritin is routinely used as a marker of iron stores; however, because it is also an acute-phase reactant, an elevated value does not necessarily indicate iron overload.^{5,6}

Observational studies have found that elevated serum ferritin in early pregnancy is associated with subsequent GDM.^{7–9} Meta-analyses have reported similar associations, although differences in gestational age at sampling, iron supplementation, maternal body composition and adjustment for confounding factors preclude the use of a universal

predictive cut-off.^{10,11} This question is particularly relevant in Indian antenatal care, where iron deficiency remains common while routine iron supplementation and gestational hyperglycaemia coexist.

Our study evaluated the relationship between serum ferritin categories and subsequent GDM occurrence among women attending a tertiary obstetric service in Rajasthan. Maternal age was examined as an additional clinical correlate.

MATERIALS AND METHODS

Study design and setting

This hospital-based prospective observational study was conducted in the Department of Obstetrics and Gynaecology, J.L.N. Medical College and Rajkiya Mahila Chikitsalaya, Ajmer, Rajasthan. The study included 251 pregnant women attending the antenatal outpatient department. The study was undertaken after institutional ethical approval.

Participants

Women presenting before 12 weeks of gestation with a singleton pregnancy, haemoglobin >10.5 g/dL, and normal thyroid, liver and renal function were considered eligible after written informed consent. Women with known diabetes, previous GDM, hypertension, active or chronic infection, renal or hepatic disease, malignancy, recent COVID-19 infection or refusal of consent were excluded in accordance with the study protocol.

Ferritin measurement and glucose screening

All eligible women underwent an initial 75-g oral glucose tolerance test using the Diabetes in Pregnancy Study Group India (DIPSI) method irrespective of fasting status. A two-hour venous plasma glucose level ≥ 140 mg/dL was used to diagnose GDM. Women with GDM at baseline were excluded from further follow-up. Serum ferritin in women screening negative was measured by chemiluminescence immunoassay using the MAGLUMI 800 analyser. GDM screening was repeated at 24–28 weeks; women remaining normoglycaemic were rescreened at 32–34 weeks.

First-trimester serum ferritin values were classified into four study-defined groups: Q1 (<30 ng/mL), Q2 (30–49 ng/mL), Q3 (50–69 ng/mL) and Q4 (≥ 70 ng/mL). The outcome was the development of GDM during subsequent antenatal follow-up.

Statistical analysis

Continuous data were summarised as mean $\pm$ standard deviation, and categorical variables as frequencies and percentages. Associations between serum ferritin groups and GDM were assessed using Pearson's chi-square test. Unadjusted odds ratios (ORs) and 95% confidence intervals (CIs) were calculated from the reported group counts with Q1 as the reference. Maternal age groups were compared separately. All tests were two-sided, and $p < 0.05$ was considered statistically significant.

Ethics

Institutional ethics approval was obtained, and all participants provided written informed consent.

RESULTS

Characteristics of the study cohort

The analysis included 251 pregnant women. The largest age group was 21–25 years (108; 43.0%). Mean serum ferritin was 58.6 ± 24.3 ng/mL. Gestational diabetes mellitus developed in 43 women (17.1%). Table 1 presents the principal demographic and biochemical characteristics.

Table 1. Selected demographic and clinical characteristics (N=251)

Characteristic	Category	Value
Age (years)	18–20	42 (16.7)
	21–25	108 (43.0)
	26–30	71 (28.3)
	>30	30 (12.0)
Serum ferritin	Mean $\pm$ SD (ng/mL)	58.6 ± 24.3
GDM status	GDM recorded	43 (17.1)

Ferritin categories and GDM occurrence

GDM occurred in 4 of 56 women (7.1%) with ferritin <30 ng/mL, 7 of 70 (10.0%) with ferritin 30–49 ng/mL, 12 of 67 (17.9%) with ferritin 50–69 ng/mL and 20 of 58 (34.5%) with ferritin ≥ 70 ng/mL. The association across the four ferritin

groups was significant ($\chi^2=18.77$; $p<0.001$). Relative to the lowest group, ferritin ≥ 70 ng/mL was associated with higher unadjusted odds of GDM (OR 6.84; 95% CI 2.16–21.66; Table 2 and Figure 1).

Table 2. Ferritin categories, GDM events and unadjusted odds ratios

Ferritin group	GDM present	GDM absent	Total	GDM (%)	Unadjusted OR (95% CI)
<30 ng/mL	4	52	56	7.1	1.00 (Ref.)
30–49 ng/mL	7	63	70	10.0	1.44 (0.40–5.21)
50–69 ng/mL	12	55	67	17.9	2.84 (0.86–9.36)
≥ 70 ng/mL	20	38	58	34.5	6.84 (2.16–21.66)
Total	43	208	251	17.1	—

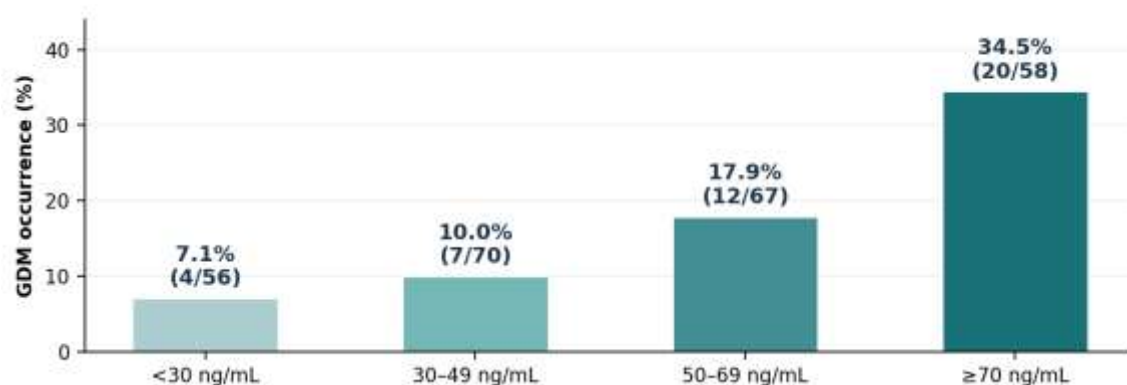


Figure 1. Gestational diabetes occurrence across first-trimester ferritin groups.

Maternal age and GDM

GDM was recorded in 14 of 150 women aged ≤ 25 years and 29 of 101 women aged >25 years. The corresponding proportions were 9.3% and 28.7%. Women older than 25 years had higher unadjusted odds of GDM (OR 3.91, 95% CI 1.95–7.87; $p<0.001$; Table 3).

Table 3. Maternal age and gestational diabetes mellitus

Age group	GDM / no GDM	Total	GDM (%)	Unadjusted OR (95% CI)
≤ 25 years	14 / 136	150	9.3	1.00 (Ref.)
>25 years	29 / 72	101	28.7	3.91 (1.95–7.87)

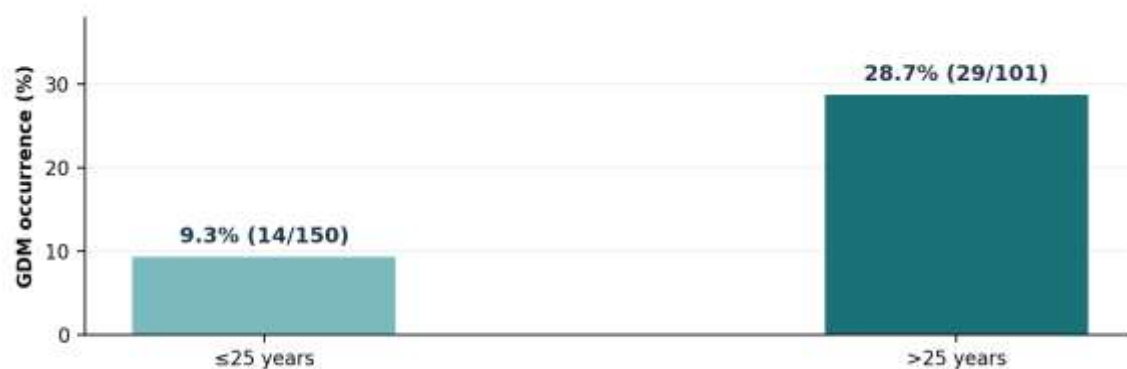


Figure 2. Gestational diabetes occurrence by maternal age group.

DISCUSSION

A graded association between early-pregnancy ferritin concentration and the subsequent development of GDM was observed. GDM occurred in about one-third of women in the highest ferritin group, compared with fewer than one in ten in the lowest group. The findings suggest that early ferritin may reflect metabolic vulnerability before routine mid-trimester glucose screening. However, the observational design does not establish that increased iron stores cause GDM.

The observed pattern is consistent with findings from the Danish National Birth Cohort, in which higher early-pregnancy plasma ferritin was associated with subsequent GDM.⁸ Similar associations were reported in a longitudinal multiracial cohort assessing iron status across pregnancy.⁹ Meta-analyses have likewise linked higher ferritin or iron status with an increased risk of GDM.^{10,11} The greater occurrence of GDM in our highest ferritin category is clinically noteworthy; however, its magnitude should not be directly compared with adjusted estimates from other settings because our analyses were unadjusted and used study-defined ferritin categories.

The association is biologically plausible. Increased iron availability may contribute to reactive oxygen species formation and pancreatic beta-cell stress; subclinical inflammation may elevate ferritin and impair insulin signalling. Pregnancy-related physiological insulin resistance can accentuate these effects.⁴ A hospital-based study from India reported higher ferritin and oxidative-stress indices among women with GDM.⁶ Because ferritin is also an acute-phase reactant, an elevated concentration should not be interpreted as proof of iron overload.

Maternal age was another important clinical correlate: GDM was more frequent among women older than 25 years (28.7%) than among younger women (9.3%). The reported ORs are unadjusted; therefore, the independent contribution of ferritin relative to maternal age and other metabolic factors cannot be determined from these comparisons. Future research should use multivariable models to examine this relationship.

Ferritin may complement clinical risk assessment, but it cannot replace glucose-based testing. The ≥ 70 ng/mL study group is not a validated clinical threshold; antenatal iron supplementation should remain guideline-based.

Strengths and limitations

Strengths include a prospective observational design with serial glucose screening, an objective laboratory ferritin assay, follow-up glucose testing, and a study population large enough for an initial category-wise comparison. The clinical setting provides data from routine tertiary obstetric practice in Rajasthan.

The study was conducted at a single centre, with 43 GDM outcomes and unadjusted comparisons. Ferritin levels are affected by inflammation and iron metabolism, and the contribution of these pathways could not be separated. This limits causal interpretation and generalisability. Future prospective multicentre studies incorporating inflammatory markers and multivariable analyses would strengthen the evidence.

CONCLUSION

Higher first-trimester serum ferritin was associated with a greater occurrence of GDM in this prospective antenatal cohort, with the highest frequency among women with ferritin ≥ 70 ng/mL. Maternal age above 25 years was also associated with increased GDM occurrence. Ferritin warrants further evaluation as a supplementary risk marker, but it cannot replace established glucose-based screening.

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