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Original Research Article

Association between Serum Ferritin and Thyroid Function among Second-Trimester Antenatal Women: A Hospital-Based Case-Control Study

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Abstract

Background: Pregnancy induces significant physiological and hormonal changes that influence thyroid function and iron metabolism. Iron deficiency remains one of the most common nutritional deficiencies among pregnant women and has been implicated in altered thyroid hormone synthesis due to the iron-dependent activity of thyroid peroxidase. Early identification of iron deficiency and thyroid dysfunction during pregnancy may reduce adverse maternal and fetal outcomes.

Aim: To evaluate the association between serum ferritin levels and thyroid function among second-trimester antenatal women.

Materials and Methods: A hospital-based case-control study was conducted from January 2025 to July 2025 among 120 second-trimester antenatal women attending the Obstetrics and Gynecology outpatient department of a tertiary care teaching hospital. Sixty pregnant women diagnosed with hypothyroidism constituted the case group, while 60 euthyroid pregnant women served as controls. Serum ferritin, free triiodothyronine (FT3), free thyroxine (FT4), thyroid-stimulating hormone (TSH), hemoglobin, and complete blood count were assessed. Statistical analysis was performed using SPSS version 27.0.

Results: Mean serum ferritin levels were significantly lower among hypothyroid pregnant women (19.82 ± 7.64 ng/mL) compared with euthyroid controls (48.36 ± 10.12 ng/mL; $p<0.001$). Serum ferritin demonstrated a positive correlation with FT3 ($r=0.462$, $p<0.001$) and FT4 ($r=0.438$, $p<0.001$), and a negative correlation with TSH ($r=-0.512$, $p<0.001$). Women with ferritin levels below 30 ng/mL exhibited significantly higher odds of hypothyroidism (OR=4.8, 95% CI: 2.1–10.9).

Conclusion: Low serum ferritin levels are significantly associated with thyroid dysfunction among second-trimester antenatal women. Routine assessment of iron stores may aid in early identification of women at risk for thyroid abnormalities during pregnancy.

Keywords: Pregnancy, Ferritin, Thyroid Function, Hypothyroidism, Iron Deficiency, Antenatal Women, TSH.

Introduction

Pregnancy represents a unique physiological state characterized by profound endocrine, metabolic, and hematological adaptations [1]. Maternal thyroid hormones are essential for fetal growth, neurological development, and maintenance of pregnancy [2]. The increased demand for thyroid hormone production during gestation necessitates adequate nutritional support, particularly iron and iodine [3]. Iron deficiency affects nearly 40–60% of pregnant women in developing countries and remains a major public health concern [4]. Iron serves as a critical cofactor for thyroid peroxidase, the enzyme responsible for iodine oxidation and thyroid hormone synthesis [5]. Deficiency of iron can impair thyroid hormone production, leading to elevated serum TSH concentrations and reduced circulating thyroxine levels [6]. Maternal hypothyroidism has been associated with miscarriage, gestational hypertension, preeclampsia, anemia, preterm birth, low birth weight, and impaired neurocognitive development in offspring [7]. Recent studies have suggested that depleted iron stores may contribute to thyroid dysfunction during pregnancy, although the strength of this association varies among populations [8]. Serum ferritin is considered the most reliable biochemical marker of body iron stores. Assessment of ferritin alongside thyroid hormone measurements may provide valuable insights into the interplay between iron metabolism

and thyroid function during pregnancy [9-11]. Considering the high prevalence of both iron deficiency and thyroid dysfunction among pregnant women in India, this study was undertaken to evaluate the association between serum ferritin levels and thyroid function among second-trimester antenatal women.

Aim: To evaluate the association between serum ferritin levels and thyroid function among second-trimester antenatal women.

Objectives

1. To estimate serum ferritin levels among second-trimester antenatal women.
2. To assess thyroid function parameters (TSH, FT3, FT4).
3. To compare serum ferritin levels between hypothyroid and euthyroid pregnant women.
4. To determine the correlation between ferritin levels and thyroid hormone profile.
5. To identify the risk of hypothyroidism associated with low ferritin levels.

Materials and Methods

This hospital-based analytical case-control study was conducted in the Department of Obstetrics and Gynecology in collaboration with the Department of Biochemistry at a tertiary care teaching hospital over a period of seven months, from January 2025 to July 2025. A total of 120 antenatal women in their second trimester of pregnancy were enrolled in the study using a consecutive sampling technique. The study population was divided into two groups: 60 pregnant women diagnosed with hypothyroidism constituted the case group, while 60 euthyroid pregnant women served as the control group. Eligible participants were pregnant women aged between 18 and 35 years with a singleton pregnancy in the second trimester (14–28 weeks of gestation) who were willing to provide written informed consent for participation. Women with a known history of thyroid disorders prior to pregnancy, chronic kidney disease, liver disease, autoimmune disorders, hemoglobinopathies, multiple pregnancies, acute infections or inflammatory conditions, and those receiving iron infusion therapy were excluded from the study to avoid potential confounding factors. Following enrollment, detailed demographic and clinical information was collected using a structured proforma. Ethical clearance for the study was obtained from the Institutional Ethics Committee before commencement of the research, and written informed consent was obtained from all participants after explaining the purpose and procedures of the study. Blood samples were collected under aseptic precautions for estimation of serum ferritin and thyroid function parameters, and the obtained data were analyzed to evaluate the association between iron stores and thyroid function among second-trimester antenatal women.

Laboratory Investigations: Following an overnight fasting period of 8–12 hours, approximately 5 mL of venous blood was collected aseptically from each participant. The blood samples were processed immediately, and serum was separated by centrifugation for biochemical analysis. Hematological parameters including hemoglobin (Hb), total leukocyte count (TLC), red blood cell (RBC) count, and packed cell volume (PCV) were assessed using an automated hematology analyzer. Biochemical investigations comprised estimation of serum ferritin levels by Chemiluminescent Immunoassay (CLIA), which served as an indicator of body iron stores. Thyroid function was evaluated by measuring serum thyroid-stimulating hormone (TSH), free triiodothyronine (FT3), and free thyroxine (FT4) using standardized Chemiluminescent Immunoassay (CLIA) techniques according to the manufacturer's instructions. Quality control procedures were followed throughout the analytical process to ensure accuracy and reliability of results. Hypothyroidism was diagnosed based on the American Thyroid Association (ATA) guidelines for pregnancy and was defined as a serum TSH level greater than 4.0 μIU/mL in the presence of reduced FT4 levels. The laboratory findings were subsequently analyzed to determine the relationship between serum ferritin concentrations and thyroid function among second-trimester antenatal women.

Statistical Analysis: All collected data were entered into Microsoft Excel and subsequently analyzed using Statistical Package for the Social Sciences (SPSS) software version 27.0. Continuous variables were expressed as mean ± standard deviation (SD), while categorical variables were presented as frequencies and percentages. The Independent Student's t-test was used to compare the mean values of continuous variables between hypothyroid and euthyroid antenatal women. The Chi-square test was applied to assess associations between categorical variables. Pearson's correlation coefficient was employed to evaluate the relationship between serum ferritin levels and thyroid function parameters, including TSH, FT3, and FT4. Logistic regression analysis was performed to identify factors associated with the risk of hypothyroidism and to estimate the corresponding odds ratios with 95% confidence intervals. A p-value of less than 0.05 was considered statistically significant for all analyses.

Result

Table 1: Baseline Characteristics of Study Participants

Parameter	Cases (n=60)	Controls (n=60)	p-value
Age (years)	25.8 ± 4.1	24.9 ± 3.8	0.213
Gestational Age (weeks)	21.4 ± 3.2	20.9 ± 3.4	0.451
BMI (kg/m²)	24.7 ± 3.6	24.1 ± 3.2	0.372
Hemoglobin (g/dL)	10.3 ± 1.2	11.5 ± 1.1	<0.001

There was no statistically significant difference in age, gestational age, or BMI between groups (Table 1). However, hemoglobin levels were significantly lower among hypothyroid women.

Table 2. Comparison of Ferritin and Thyroid Function Parameters

Parameter	Cases	Controls	p-value
Ferritin (ng/mL)	19.82 ± 7.64	48.36 ± 10.12	<0.001
FT3 (pg/mL)	2.41 ± 0.52	3.14 ± 0.61	<0.001
FT4 (ng/dL)	0.81 ± 0.14	1.16 ± 0.18	<0.001
TSH (µIU/mL)	6.74 ± 1.85	2.31 ± 0.76	<0.001

Serum ferritin was significantly reduced among hypothyroid women. FT3 and FT4 were significantly lower, whereas TSH was significantly higher in cases compared to controls (Table 2).

Table 3. Correlation of Ferritin with Thyroid Profile

Parameter	Correlation Coefficient (r)	p-value
Ferritin vs FT3	+0.462	<0.001
Ferritin vs FT4	+0.438	<0.001
Ferritin vs TSH	-0.512	<0.001

A moderate positive correlation was observed between ferritin and thyroid hormones, whereas a negative correlation was noted with TSH (Table 3).

Table 4. Logistic Regression Analysis for Risk of Hypothyroidism

Variable	Odds Ratio	95% CI	p-value
Ferritin <30 ng/mL	4.8	2.1–10.9	<0.001
Hb <11 g/dL	2.7	1.3–5.8	0.009
BMI >25 kg/m²	1.4	0.7–2.9	0.274

Women with ferritin levels below 30 ng/mL had nearly five times higher odds of hypothyroidism.

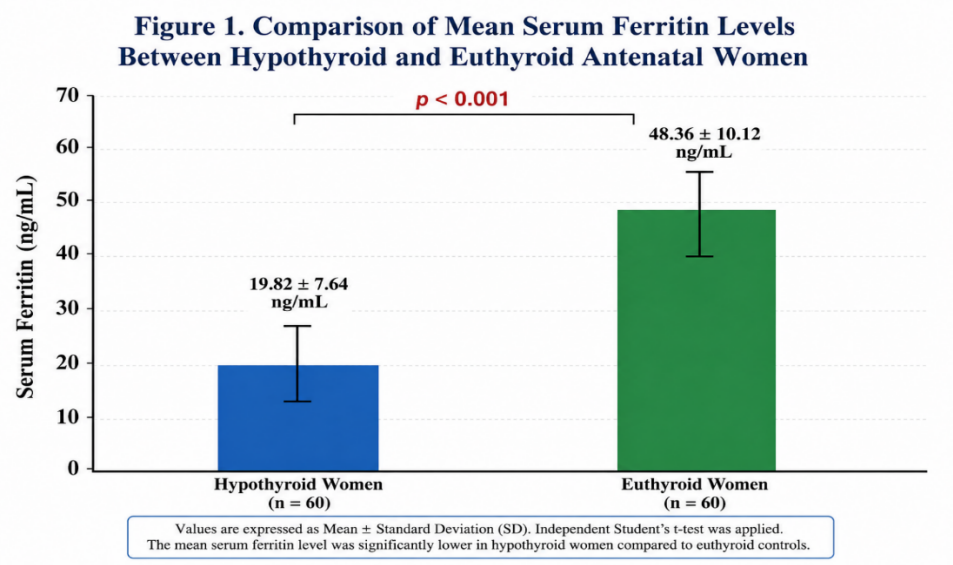

Figure 1. Comparison of Mean Serum Ferritin Levels Between Hypothyroid and Euthyroid Antenatal Women

Figure 1: Bar chart showing the comparison of mean serum ferritin levels between hypothyroid and euthyroid second-trimester antenatal women. The mean serum ferritin level was significantly lower among hypothyroid women (19.82 ± 7.64 ng/mL) compared to euthyroid controls (48.36 ± 10.12 ng/mL) ($p < 0.001$), indicating a significant association between reduced iron stores and thyroid dysfunction during pregnancy.

Discussion

The present study demonstrated a significant association between low serum ferritin levels and altered thyroid function among second-trimester antenatal women [12]. Women diagnosed with hypothyroidism exhibited substantially lower ferritin concentrations compared with euthyroid controls [13-15].

The findings support the biological role of iron in thyroid hormone synthesis. Thyroid peroxidase is a heme-dependent enzyme requiring adequate iron availability for optimal activity. Iron deficiency may impair iodination of tyrosine residues and decrease synthesis of thyroid hormones [16-17].

Our findings are comparable to those reported by Zimmermann et al., who demonstrated reduced thyroid hormone concentrations among iron-deficient pregnant women. Hess et al. similarly observed decreased thyroid peroxidase activity associated with iron deficiency [18-19].

The significant negative correlation between ferritin and TSH observed in the present study suggests that depletion of iron stores contributes to compensatory elevation of pituitary TSH secretion. Similar findings were reported by Yu et al., who observed elevated TSH among pregnant women with low ferritin concentrations [20-22].

The positive correlations between ferritin and FT3/FT4 further emphasize the influence of iron status on thyroid hormone production. These findings are consistent with studies by Beard et al. and Veltri et al., who demonstrated improved thyroid hormone levels following correction of iron deficiency [23-25].

The logistic regression analysis revealed that women with ferritin levels below 30 ng/mL had nearly five-fold increased risk of hypothyroidism. This finding highlights the importance of screening for iron deficiency during antenatal care.

The study reinforces the need for integrated evaluation of iron status and thyroid function during pregnancy, particularly in populations with high prevalence of nutritional deficiencies.

Strengths of the Study

- Adequate sample size.
- Inclusion of matched controls.
- Simultaneous assessment of ferritin and thyroid profile.
- Use of standardized laboratory techniques.

Limitations

- Single-center study.
- Lack of follow-up into the third trimester.
- Thyroid autoantibodies were not measured.
- Causal relationship could not be established.

Conclusion

Serum ferritin levels are significantly associated with thyroid function among second-trimester antenatal women. Iron deficiency is linked with elevated TSH and reduced thyroid hormone concentrations. Routine screening for ferritin levels alongside thyroid function tests may facilitate early diagnosis and management of thyroid dysfunction during pregnancy, thereby improving maternal and fetal outcomes.

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