Research Article

A Study of Serum Iron Profile and Thyroid Profile in Hypothyroid Patients

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ABSTRACT

Introduction: Hypothyroidism a common endocrine disorder has been linked to alterations in iron metabolism. Changes in iron metabolism and its deficiency may impair thyroid hormone production.The present study aimed to estimate serum iron profile among hypothyroid patients.

Materials and Methods: This cross-sectional study was conducted at Jawaharlal Nehru Institute Of Medical Sciences, Imphal, during the period from March 2023 to Febuary 2025. Ethical approval was taken from the institutional Ethics Committee JNIMS, Imphal. The Serum Iron and Serum TIBC were measured using Automated photometric systems on Diasys Sys 200 Pro. Serum Ferritin by ELISA method. This study consists of 192 lab-diagnosed hypothyroid cases based on the thyroid profile. Data was analyzed by using SPSS v22.

Results: Among total 192 study subject's majority 41.15% of them were in the age group 31-40 years. Mean TSH level in males (16.79 ± 21.79) was significantly higher than in females (10.45 ± 7.89), with a p-value of 0.005.There was statistically significant positive correlation between TSH and TIBC ($r = 0.433$, $p < 0.001$) and while statistically negative correlation between TSH and ferritin and between TSH and serum iron ($p < 0.001$).

Conclusion: The correlation analysis reveals that as TSH levels increase, serum ferritin and iron levels decrease while TIBC increases, indicates an association between hypothyroidism and iron deficiency. This highlights the importance of monitoring iron status in individuals with hypothyroid and to ensure timely diagnosis and management of disease outcome.

Keywords: Thyroid Stimulating Hormone, Serum Iron, Total Iron Binding Capacity, Serum Ferritin.

1. INTRODUCTION

Thyroid gland is a butterfly shaped endocrine gland, located in lower part of the neck. They contain follicular cells which is responsible for synthesis of thyroid hormones T3 and T4. Besides the follicular cells, they also contain par follicular cells which synthesize calcitonin [1].

Hypothyroidism is a common endocrine disorder with reduced production of thyroid hormones. It is characterized biochemically by a reduction in serum T3 and T4 levels that result in an increase in serum thyroid stimulating hormone (TSH) concentration [2], affecting diverse populations worldwide, with a prevalence of approximately 5%, including iodine-replete regions [3, 4]. Iron metabolism and thyroid hormones are closely related as the synthesis and metabolism of thyroid gland are found to be dependent on many trace elements which includes iron, iodine, selenium and zinc [5]. Role of Iron in Thyroid Function: Iron is required for thyroid hormone synthesis.The enzyme thyroid peroxidase (TPO), which helps convert iodide to iodine and form T3/T4, is heme (iron)-dependent.Iron deficiency impairs TPO activity and decrease thyroid hormone production. The relation between iron and thyroid hormone biosynthesis includes thyroid peroxidase (TPO) which is essential for two important reaction of thyroid hormone biosynthesis [6]. First, it acts as a membrane bound enzyme responsible for the oxidation of iodide and secondly, it helps in binding of iodine to tyrosyl residue of thyroglobulin [7]. Iron metabolism is very closely related to thyroid

hormone metabolism. Iron plays a pivotal role in thyroid hormone synthesis as it is an essential cofactor for thyroid peroxidase (TPO), the heme-containing enzyme responsible for iodide oxidation and the coupling of iodotyrosine residues to form T_3 and T_4. Iron deficiency reduces TPO activity, leading to decreased synthesis of thyroid hormones and a compensatory rise in TSH. Moreover, iron deficiency alters deiodinase enzyme activity, impairing the peripheral conversion of T_4 to T_3. These mechanisms explain the bidirectional link between hypothyroidism and iron deficiency—hypothyroidism can also reduce gastrointestinal iron absorption, aggravating anemia. Estimation of serum ferritin (storage form), iron and total iron binding capacity (TIBC), which measures percent saturation of transport form transferrin with iron, may be of great significance in hypothyroidism [5]. Iron deficiency is another global health issue that can present with clinical manifestations similar to hypothyroidism, like fatigue, lethargy, muscle weakness, intolerance to cold, and depression [8, 9]. It has been reported a decrease in iron storage levels in individuals with hypothyroidism, indicating a potential association between iron status and reflect thyroid function [10]. One of the causes of low iron level and hypothyroid being more common in females may be the menstrual irregularities. This factor may aid to the statement that there is a strong correlation between iron metabolism and hypothyroidism [11].

Therefore the present study has been taken up to evaluate between Serum iron profile and thyroid profile in hypothyroid patients.

2. MATERIALS AND METHODS

This hospital based cross-sectional study was conducted in the Department of Biochemistry in collaboration with the Department of Endocrinology, Jawaharlal Nehru Institute of Medical Sciences (JNIMS), Imphal after obtaining ethical clearance and approval from the Institutional Ethics Committee, JNIMS, Imphal (Ref no-Ac/03/IEC/JNIMS/2018-PGT) from March 2023 to Feb 2025. The study population comprises of 192 newly diagnosed hypothyroid patients in the Department of Endocrinology, JNIMS, Imphal.

By using the formula : Z^2pq/e^2

where, z= confidence limit

p= prevalence

q= 1-p

e= allowable error

Z^2pq/e^2 = 1.96x1.96x43x57/49 =192

A sample size of 192 was chosen based on the availability of laboratory-confirmed cases during the study period that fulfilled the inclusion and exclusion criteria, ensuring uniformity and reliability of biochemical data. The thyroid function parameters were estimated using chemiluminescence immunoassay analyzer (CLIA). The Serum Iron and Serum TIBC were measured using automated photometric systems on Diasys Sys 200 Pro. Serum Ferritin by Enzyme-linked immunosorbent assay (ELISA) method. Statistical analysis was done by using SPSS v22. Analytical statistics like independent t-test and Pearson correlation analysis were also used and p-value ≤ 0.05 was considered as statistically significant.

3. RESULTS

In the present study, a total of 192 newly diagnosed hypothyroid patients were participated.

Majority of the patients were in the age group of 31-40 years (41.15%) followed by 18-30 years category with 31.78% .The 41-50 years age group constituted 21.36%, while the least represented category is the 51-60 years group, with only 5.73% of the total population as shown in [Table 1].

Table: 1 : Age distribution of the patients

Age Group	No of Patients	Percentage (%)
18-30	61	31.78
31-40	79	41.15
41-50	41	21.36
51-60	11	5.73
Total	192	100

It was a female preponderance in the study population (84.9% and 15.1% in females and males respectively) as shown in [Table 2].

Table: 2: Distribution of the patients by sex

Sex	No of Patients	Percentage (%)
Male	29	15.1
Female	163	84.9
Total	192	100.0

The mean TSH level in males (16.79 ± 21.79) was significantly higher than in females (10.45 ± 7.89), with a t-value of 2.835 and a p-value of 0.005. However, no significant differences were found in T3 (p- value=0.563) and T4 (p-value=0.977 levels between males and females as shown in [Table 3].

Table: 3: Mean ± SD of male and female of thyroid function parameters

Sex		No. of patients	Mean ± SD	t value	p-value
TSH (µIU)	Male	29	16.7 ±21.7	2.835	0.005
	Female	163	10.45±7.8		
T3 (ng/mL)	Male	29	0.41±0.41	-0.580	0.563
	Female	163	0.42±0.50		
T4 (µg/dL)	Male	29	5.34±7.09	0.029	0.977
	Female	163	5.30±6.46		

Regarding the iron profile, males had a slightly higher mean ferritin level (9.35 ± 1.92), compared to females (8.96 ± 1.83), but this difference was not statistically significant (p = 0.293). Similarly, the mean serum iron level was higher in males (31.69 ± 4.42) compared to females (30.58 ± 4.93), but again, the difference was not significant (p = 0.259). The Total Iron Binding Capacity (TIBC) was also higher in males (470.79 ± 34.30) compared to females (457.87 ± 42.16), though this difference did not reach statistical significance (p = 0.120) as shown in [Table 4].

Table: 4: Mean ± SD of male and female of iron profile parameters

Sex		No. of patients	Mean±SD	t value	p-value
S. FERRITIN (ng/mL)	Male	29	9.34±1.9	1.053	0.293
	Female	163	8.95±1.8		
S. IRON (µg/dL)	Male	29	31.6±4.4	1.133	0.259
	Female	163	30.5±4.9		
S. TIBC (µg/dL)	Male	29	470.7±34.3	1.561	0.120
	Female	163	457.8±42.1		

Pearson correlation between TSH and serum ferritin (r = -0.412) and between TSH and serum iron (r = -0.266) indicates negative correlation which shows statistically insignificant (p>0.05) shown in [Table 5].

Pearson correlation between TSH and TIBC indicates positive correlation (r = 0.433) and the finding was statistically significant (p<0.05)[Table 6] .This correlation was shown in the scattered diagram [Figure 1].

Table: 5: Correlation between thyroid function parameters and Iron profile

Test parameters	Pearson correlation	p-value
TSH and serum ferritin	-0.412	0.000
TSH and serum iron	-0.266	0.000
TSH and serum TIBC	0.433	0.000
T3 and serum ferritin	0.409	0.000
T3 and serum iron	0.389	0.000
T3 and serum TIBC	-0.428	0.000
T4 and serum ferritin	0.061	0.397
T4 and serum iron	0.048	0.511
T4 and serum TIBC	-0.026	0.720

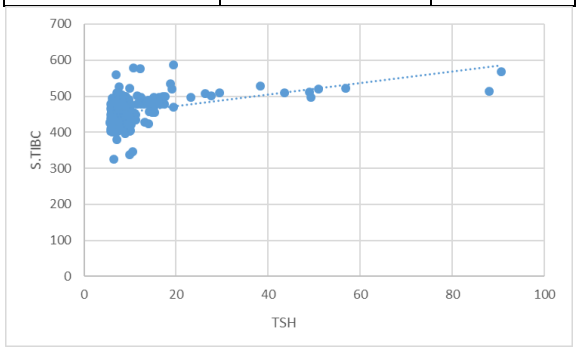

Figure: 1: Correlation between TSH and S. TIBC

T3 levels showed a strong positive correlation with ferritin (r = 0.409, p < 0.001) and serum iron (r = 0.389, p < 0.001). Negative correlation was found between T3 and TIBC (r = -0.428, p < 0.001). This negative correlation was shown in the scattered diagram [Figure 2].

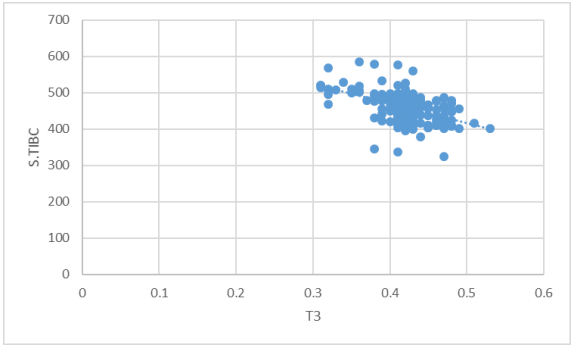

Figure: 2: Correlation between T3 and S. TIBC

No significant correlations were observed between T4 and ferritin (p = 0.397), serum iron (p = 0.511), and TIBC (p = 0.720) [Table 5].

4. DISCUSSION

Our study showed a clinically relevant interaction between thyroid function and iron metabolism that warrants consideration in the management of hypothyroid patients. The present study investigated the relationship

between iron profile and thyroid function in 192 patients diagnosed with hypothyroidism. In our study population, the majority of the patients were in the age group of 31-40 years (41.15%) which was similar to a study conducted by Zehra et al., [12] and Das *et al.,* [11] .

The present study observed a strong female predominance (84.9%), which is consistent with a study reported by Mishra *et al.,* [13] (73.3%) and Zehra *et al.,* [12] (81%).

In the present study, mean TSH level was significantly higher in males (16.79 ± 21.79 μIU/mL) compared to females (10.45 ± 7.89 μIU/mL), which was statistically significant ($p = 0.005$). This may be attributed to delayed diagnosis or more advanced disease presentation among male patients, as males generally seek medical evaluation later for thyroid-related symptoms. Further study conducted by Zehra *et al.,* [12] which reported a mean TSH level of 46.12 ± 15.8 μIU/mL, highlighting a more pronounced thyroid dysfunction in their study population. In contrast, T3 and T4 levels did not show significant gender-based differences ($p = 0.563$ and $p = 0.977$, respectively).

Previous study done by Erdogan *et al.,* [14] reported 49.87 ± 36.25 μg/L in overt hypothyroid and 58.43 ± 33.58 μg/L in subclinical cases. Our study found significantly lower ferritin (9.34 ± 1.92 ng/mL in males and 8.95 ± 1.83 ng/mL in females) levels, possibly due to differences in nutritional status and sample demographic level. Serum iron levels in our study were 31.68 ± 4.41 μg/dL in males and 30.58 ± 4.93 μg/dL in females suggested a greater degree of iron deficiency compared to study done by Chatterjee *et al.,* [15] found iron levels of 62.38 ± 27.42 μg/dL in hypothyroid cases. The link between hypothyroidism and iron deficiency is bidirectional, meaning each condition can worsen the other. Iron deficiency reduces thyroid hormone production, while hypothyroidism decreases iron absorption and utilization - creating a bidirectional relationship that worsens both conditions.

In this study, TIBC levels were 470.79 ± 34.30 μg/dL in males and 457.86 ± 42.16 μg/dL in females while Kumar *et al.,* [16] found 381.54 ± 82.39 μg/dL. Elevated TIBC values indicate an increased iron-binding capacity, possibly reflecting a higher levels of iron deficiency in our study population.

In this study, TSH showed a significant negative correlation with serum ferritin ($r = -0.412$), and serum iron ($r = -0.266$), while TSH was positively correlated with TIBC ($r = 0.433$, $p = 0.000$). These findings were consistent with Sachdeva *et al.,* [17] and Brown et al. [18] which reported a stronger negative correlation of TSH with ferritin ($r = -0.58$) and serum iron ($r = -0.47$), as well as a positive correlation with TIBC ($r = 0.39$).

Their study further confirmed that increased TSH levels were linked to higher TIBC ($r = 0.452$, $p < 0.001$), supporting our hypothesis that iron deficiency might contribute to thyroid dysfunction.

T_3 is the biologically active form of thyroid hormone that regulates metabolic rate, oxygen consumption, and protein synthesis, while T_4 acts as a prohormone converted to T_3 in peripheral tissues. Adequate iron availability enhances TPO and deiodinase enzyme function, supporting normal T_3 and T_4 production. Our study showed a positive correlation between T3 and serum ferritin ($r = 0.409$) and serum iron ($r = 0.389$), and the finding was statistically significant $p< 0.05$ while T3 was negatively correlated with TIBC ($r = -0.428$). This is in concordance with the study done by Dahiya *et al.,* [2] and Akhter et al.[19] which reported r values between 0.37 and 0.58 for T3 and ferritin, and also positive correlations for T3 and serum iron. These findings support the role of iron in thyroid hormone synthesis and metabolism, suggesting that higher iron availability is linked to increased T3 levels.

This study found no significant correlation between T4 and serum ferritin ($r = 0.061$, $p = 0.397$), serum iron ($r = 0.048$, $p = 0.511$) and TIBC ($r = -0.026$, $p = 0.720$).

This contrasts with previous studies, such as Sachdeva *et al.,* [17], Chatterjee *et al.,* [15] and Kumar *et al.,* [16] which reported significant positive correlations between T4 and ferritin ($r = 0.43$ to 0.57) and serum iron ($r = 0.41$ to 0.51). The reason for such discrepancy may be due to differences in study populations, sample sizes, inclusion of subclinical thyroid dysfunction cases

in their study. However, the absence of a significant correlation between T4 and iron parameters in our study suggests the need for further investigation. Overall, our findings corroborate the existing literature, particularly the inverse relationship between TSH and iron parameters and the positive relationship between T3 and ferritin. Iron deficiency has been shown to impair thyroid hormone synthesis by reducing the activity of thyroid peroxidase, a key enzyme in hormone production. This interplay highlights the clinical importance of monitoring iron status in individuals with thyroid dysfunction and considering iron supplementation as a potential adjunct in hypothyroid patients with iron deficiency. The association between hypothyroidism and iron deficiency is clinically significant. Iron deficiency can exacerbate hypothyroidism by impairing thyroid hormone synthesis, while hypothyroidism can worsen anemia by reducing erythropoietin production and intestinal iron absorption. Therefore, monitoring iron status-including ferritin, serum iron, and TIBC-should be an integral part of the biochemical evaluation of hypothyroid patients. Correcting iron deficiency may improve thyroid hormone synthesis, optimize levothyroxine therapy, and enhance overall clinical outcomes.

LIMITATIONS

This was a cross-sectional study which precludes establishing causal relationships between iron deficiency and thyroid dysfunction. This study did not measure anti-thyroid antibodies to differentiate between autoimmune and non-autoimmune causes of hypothyroidism.

CONCLUSION

Our finding reveals that as TSH levels increase, serum ferritin and iron levels decrease while TIBC increases, indicating a possible link between hypothyroidism and iron deficiency. On the other hand, higher T3 levels are associated with better iron status, suggesting that iron may play a role in thyroid hormone regulation. The lack of significant correlations between T4 and iron parameters suggests that T3 might be a more useful parameter for evaluating iron-thyroid interactions. These results emphasize the importance of monitoring iron levels in hypothyroid patients, as iron deficiency could potentially exacerbate thyroid dysfunction. Monitoring iron status in hypothyroid patients helps ensure proper thyroid hormone production, improves response to therapy, identifies coexisting anemia, and prevents mismanagement of thyroid dosage. Further research are required to explore the underlying mechanisms of this relationship and to evaluate the potential benefits of iron supplementation in hypothyroid patients.

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CONFLICT OF INTEREST

The authors declare no conflicts of interest.

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