



Original Article

A Study Of Thyroid Profile In Non-Pregnant Females of Reproductive Age Group With Moderate To Severe Iron Deficiency Anemia In Hadoti Region: A Cross-Sectional Study

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ABSTRACT

Background: Iron deficiency anemia (IDA) is highly prevalent among women of reproductive age and may influence thyroid function through impaired thyroid peroxidase activity.

Aim: To evaluate thyroid function in non-pregnant females of reproductive age group with moderate to severe IDA.

Methods: This cross-sectional study was conducted in the Department of Biochemistry, Government Medical College, Kota from December 2024 to November 2025. A total of 180 non-pregnant females of reproductive age group were enrolled. Serum thyroid profile (TSH, FT3, FT4), serum ferritin and hemoglobin levels were measured using standard biochemical methods and statistically analyzed.

Results: Out of 180 subjects 80% (N=144) subjects have moderate anemia and 20% (N=36) subjects have severe anemia.

Mean FT3 level in moderate anemia subjects was 3.06 pg/ml and mean FT3 level in severe anemia subjects was 3.10 pg/ml. mean FT4 level in moderate anemia subjects was 1.20 ng/dl and mean FT4 level in severe anemia subjects was 1.18 ng/dl. No Significant reduction in FT3 and FT4 levels observed in IDA patients.

Mean TSH level in severe anemia subjects was significantly higher than mean TSH level in moderate anemia subjects (4.15 pg/ml in moderate anemia subjects and 9.70 pg/ml in severe anemia subjects)

TSH levels showed increasing trend with decreasing Hb level. TSH has significantly negative correlation with serum ferritin whereas FT3 and FT4 has no significantly correlation with serum ferritin.

Conclusion: The present study demonstrates a strong clinical and hematological correlation between anaemia and subclinical hypothyroidism. Higher proportion of anaemic subjects have subclinical hypothyroidism. The severity of anaemia increased with higher TSH levels and lower FT3/FT4 values. Iron deficiency significantly affects thyroid function, suggesting the need for routine thyroid screening in IDA patients.

Keywords: Iron deficiency anemia, Thyroid profile, TSH, T3, T4, Ferritin.

INTRODUCTION

Iron deficiency anemia (IDA) is the most prevalent nutritional deficiency disorder worldwide and remains a major public health concern, particularly in developing countries. Women of reproductive age are especially vulnerable due to increased physiological demands, menstrual blood loss, and often inadequate dietary intake. The World Health Organization (WHO) estimates that a substantial proportion of women globally are affected by anemia, with iron

deficiency accounting for the majority of cases [1]. Beyond its well-established effects on oxygen transport and physical performance, iron deficiency has significant systemic consequences, including its impact on endocrine function [2].

Iron is an essential micronutrient involved in numerous biochemical processes such as oxidative metabolism, DNA synthesis, and enzymatic reactions [3]. One of its critical yet often under-recognized roles is in thyroid hormone synthesis and metabolism. Thyroid peroxidase (TPO), a key enzyme in thyroid hormone biosynthesis, is a heme-dependent enzyme that requires adequate iron for optimal activity [4]. It catalyzes the iodination of tyrosine residues in thyroglobulin and facilitates the coupling reactions necessary for the formation of triiodothyronine (T3) and thyroxine (T4). In conditions of iron deficiency, reduced TPO activity may impair thyroid hormone synthesis [5].

In addition to its role in hormone production, iron deficiency may also influence the peripheral metabolism of thyroid hormones. The conversion of T4 to the biologically active T3 is mediated by deiodinase enzymes, which may be indirectly affected by iron status [6]. Consequently, iron deficiency can lead to decreased circulating levels of T3 and T4, along with a compensatory rise in thyroid-stimulating hormone (TSH), potentially resulting in subclinical or overt hypothyroidism [7].

Several clinical and experimental studies have investigated the association between iron deficiency and thyroid dysfunction. Evidence indicates that individuals with iron deficiency anemia often exhibit altered thyroid hormone profiles, including reduced T3 and T4 levels and elevated TSH [8,9]. Furthermore, the prevalence of subclinical hypothyroidism appears to be higher among individuals with moderate to severe anemia [10]. However, the extent to which the severity of anemia influences thyroid dysfunction remains unclear, with inconsistent findings reported across different populations [11].

The coexistence of iron deficiency anemia and thyroid dysfunction has important clinical implications. Both conditions independently contribute to symptoms such as fatigue, weakness, cognitive impairment, and reduced quality of life [12]. When present concurrently, they may exacerbate one another, complicating diagnosis and management. Additionally, untreated thyroid dysfunction in patients with iron deficiency anemia may impair the response to iron therapy and delay hematological recovery [13].

Despite the recognized interaction between iron status and thyroid function, region-specific data remain limited, particularly in the Hadoti region. Factors such as socioeconomic status, dietary patterns, and healthcare accessibility may influence both the prevalence and severity of these conditions [14]. Therefore, localized studies are essential to better understand this relationship and to inform clinical practice.

MATERIAL AND METHODS

This study was carried out in the Department of Biochemistry, Government Medical College, and Central Laboratory NMCH and MBS Hospital Kota.

Study design

This study design was an observational cross-sectional study.

Material

Questionnaire, hemoglobine, total iron, ferritin, TSH, FT3, FT4.

Study group

The study population was 180 non-pregnant female of reproductive age group with moderate to severe Iron Deficiency Anemia residing at Hadoti region of Rajasthan, India.

INCLUSION CRITERIA:

1. All non-pregnant females (15-45 years) diagnosed with moderate to severe anemia.
2. Patients who were willing to participate in the study and have given written consent.

EXCLUSION CRITERIA:

1. Patients with autoimmune disorders.
2. Patient with already diagnosed thyroid disorder and thyroid treatment.
3. Patients with diagnosed with other type of anemia.
4. Patients with smoking and alcohol abuse.
5. Patients with Hepatic disorder, Renal diseases.
6. Patients on Iron supplement.
7. Patients with chronic infections

8. Patients with DUB or acute GI bleed
9. Critically ill patients admitted in intensive care unit.

Methodology

Venous blood was drawn from each subject into EDTA vial for CBC and into a plain vial for thyroid and iron profile. Plain vial sample allowed to clot. After centrifuging the sample for 10 min at 3000 rpm, serum was separated and analyzed for thyroid profile and iron profile within a few hours of collection. All biochemical investigations were carried out on DIOSORIN auto-analyzer which functions on Principle of Chemiluminescence immunoassay and fully automated biochemistry analyzer. For CBC, EDTA vial sample mixed well gently and put in cell counter auto analyzer.

Following assays was done:

- 1) CBC
- 2) Serum FT3
- 3) Serum FT4
- 4) Serum TSH
- 5) Serum ferritin
- 6) Serum unsaturated iron binding capacity
- 7) Serum total iron
- 8) Serum Total iron binding capacity

Observation

Table 1: Distribution of study subjects according to severity of anemia

Anemia severity	N	Percentage
Moderate	144	80
Severe	36	20
Total	180	100

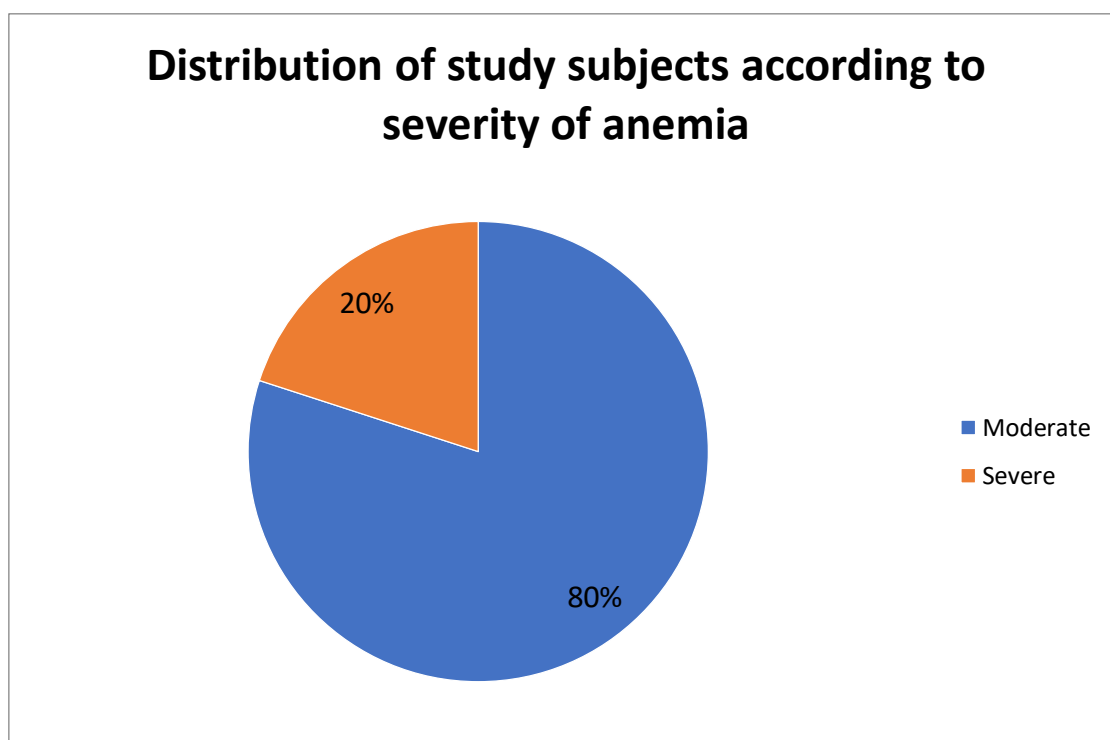


Table 2: Thyroid Function vs Severity of Anemia.

Parameter	Moderate Anemia	Severe Anemia	p-value
TSH (μ IU/ml)	4.15 \pm 1.43	9.70 \pm 1.16	<0.001
fT3 (pg/ml)	3.10 \pm 0.52	3.06 \pm 0.55	0.993
fT4 (ng/dl)	1.20 \pm 0.25	1.18 \pm 0.23	0.600

Table 2 shows that TSH significantly elevated in severe anemia, and FT4 and FT3 not significant with anemia.

Table 3: Thyroid Status Distribution

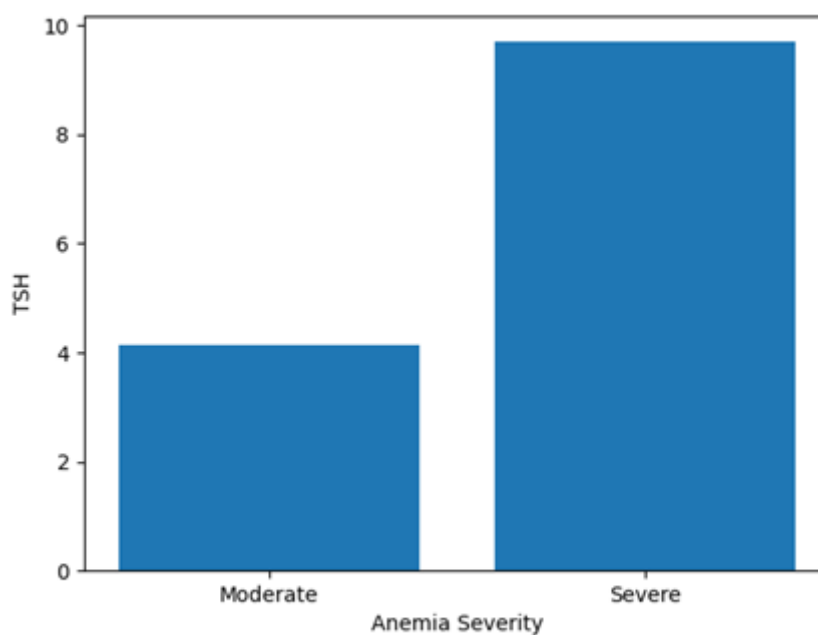
Thyroid Status	Moderate Anemia (%)	Severe Anemia (%)
Normal	83.3%	55.6%
Subclinical Hypothyroidism	16.7%	44.4%

Above table shows that subclinical hypothyroidism seen significantly in cases of severe anemia ($p < 0.001$).

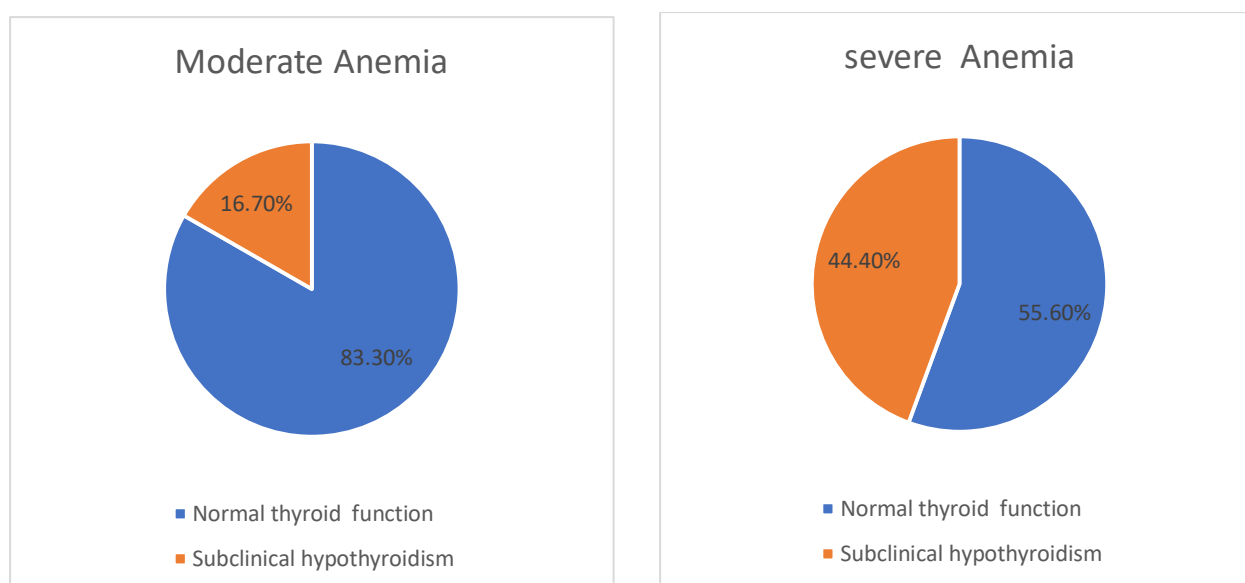
Table 4: Correlation (Ferritin vs Thyroid function)

Parameter	r value	p-value
fT3	0.328	NS
fT4	0.247	NS
TSH	-0.925	<0.001

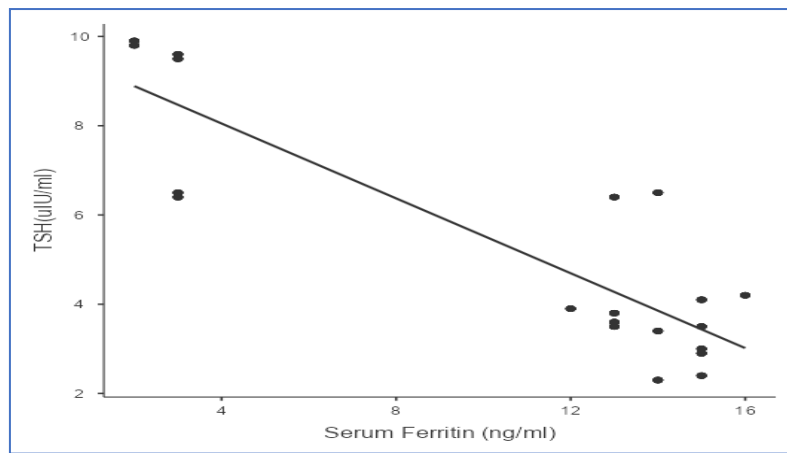
Above table shows that there is strong negative correlation of ferritin with TSH.



Graph 1: Mean of TSH vs Severity of anemia



Graph 2: Thyroid Status Distribution with severity of anemia (moderate and severe).



Graph 3: Ferritin vs TSH

- $r = -0.925$

Extremely strong negative correlation between Ferritin and TSH.

RESULTS

The mean serum TSH levels was significantly higher in subjects with severe anemia ($9.70 \pm 1.16 \mu\text{IU/ml}$) compared to those with moderate anemia ($4.15 \pm 1.43 \mu\text{IU/ml}$), and this difference was statistically highly significant ($p < 0.001$). In contrast, no statistically significant difference was observed in serum FT3 ($p = 0.993$) and FT4 ($p = 0.600$) levels between the two groups.

The prevalence of subclinical hypothyroidism was markedly higher in the severe anemia group (44.4%) as compared to the moderate anemia group (16.7%), indicating a significant association between severity of anemia and thyroid dysfunction ($p < 0.001$).

Correlation analysis revealed a strong negative correlation between serum ferritin and TSH levels ($r = -0.925$, $p < 0.001$), suggesting that declining iron stores are associated with increasing TSH levels. However, no significant correlation was observed between serum ferritin and FT3 or FT4 levels.

These findings indicate that worsening iron deficiency is associated with progressive alterations in thyroid function, particularly reflected by elevated TSH levels and increased prevalence of subclinical hypothyroidism

DISCUSSION

In present study out of 180 subjects the maximum subjects belonged to 16-25 years age group and mean age of subjects was 29.79 ± 8.53 years. Out of 180 subjects 67.2% (N=121) subjects belonged to rural background and 32.8% (N=59) subjects belonged to urban background.

Similarly in the study conducted by Neha Gupta [15] et al mean age of subjects was 22.44 ± 2.42 years which is comparable with results of present study.

Out of 180 subjects 22.2% (N=40) subjects have subclinical hypothyroidism and 77.8% (N=140) subjects have normal Thyroid status and severe anemia subjects have significantly higher prevalence of Subclinical hypothyroidism as compared to moderate Anemia subjects (44.4% in severe anemia subjects versus 16.7% in moderate anemia subjects). In a similar study, Mishra et al. [16] found that the prevalence of subclinical hypothyroidism was 18.22% in anemia with a considerable proportion exhibiting hemoglobin levels below 10 g%. Das et al. [17] reported the prevalence of subclinical hypothyroidism was 26.6% in anemia subjects.

In present study TSH has significantly negative correlation with serum ferritin. Similarly Banday TH et al. [18], and Das et al. [17] in their study found that TSH has significantly negative correlation with serum ferritin which is in agreement with results of present study.

CONCLUSION

The present study demonstrates a significant association between iron deficiency anemia and thyroid dysfunction, particularly in the form of elevated TSH levels and increased prevalence of subclinical hypothyroidism.

The severity of anemia was found to be directly related to the degree of thyroid dysfunction, with severely anemic subjects exhibiting significantly higher TSH levels and a greater proportion of subclinical hypothyroidism compared to moderately anemic individuals. The strong negative correlation between serum ferritin and TSH further highlights the critical role of iron status in maintaining normal thyroid function.

Although FT3 and FT4 levels remained within normal limits in most subjects, the elevated TSH levels suggest an early or compensatory stage of thyroid dysfunction, indicating subclinical hypothyroidism.

These findings emphasize that iron deficiency not only affects hematological parameters but also has a substantial impact on endocrine function. Therefore, routine screening of thyroid profile in patients with moderate to severe iron deficiency anemia should be considered for early detection and appropriate management.

Furthermore, correction of iron deficiency may play a beneficial role in improving thyroid function, thereby reducing morbidity and improving overall patient outcomes.

LIMITATIONS

There are several limitations in our study.

1. This is a cross-sectional study, we could not infer causal relationships between thyroid function and iron deficiency anemia. Prospective studies are expected to confirm the associations among low FT4, low FT3 and high TSH in patients of moderate to severe iron deficiency anemia patients.
2. Subjects included in this study were moderate to severe iron deficiency anemia patients female patients in a single tertiary level center institute. Thus, the results may not be representative of the entire moderate to severe iron deficiency anemia patients population.
3. THYROID PROFILE, IRON PROFILE, and CBC tests were only measured once. For this reason, the results could not be estimated in prevalence and the correlations.
4. Assays (e.g., chemiluminescence for TSH/FT3/FT4, ferrozine for iron) are standard but omit thyroid autoantibodies (anti-TPO, anti-Tg) or other influencers like selenium, iodine, or vitamin D levels. And Broader Concerns Regional focus which ignores national variations in anemia prevalence

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