ISSN 2664-4169 (Print) & ISSN 2664-7923 (Online)
**South Asian Research Journal of Biology and Applied Biosciences**
*Abbreviated Key Title: South Asian Res J Bio Appl Biosci*

**| Volume-8 | Issue-3 | May-Jun -2026 |** **DOI: https://doi.org/10.36346/sarjbab.2026.v08i03.009**

**Original Research Article**

# Immunological and Hormonal Study of Patients with Thyroid Disorders in Cases of Hyperthyroidism or Hypothyroidism

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**Article History**
Received: 14.04.2026
Accepted: 05.06.2026
Published: 08.06.2026

**Abstract:** Any thyroid dysfunction has broad systemic effects, extending beyond mere hormonal imbalances to include inflammatory and immune responses. This study aimed to assess thyroid hormons and C-reactive proteins (CRP) in patients with hyperthyroidism and hypothyroidism, comparing them to a control group of healthy individuals. Materials and methods: This study was conducted between June and October 2025, and included 90 participants (30 with hyperthyroidism, 30 with hypothyroidism, and 30 healthy individuals as a control group). The results showed significant differences in thyroid hormone levels between the two patient groups and the control group. Hyperthyroid patients showed a marked decrease in T3 and T4 levels ($p < 0.001$). While decrease in hypothyroidism patients. CRP levels were significantly higher in both hyperthyroid (27.87 ± 22.12 mg/dL) and hypothyroid (24.06 ± 23.08 mg/dL) patients as compared to the control group (0.38 ± 0.52 mg/dL). ***Conclusion*:** The present study concluded increase T4, T3 in hyperthyroid patients, while decrease in hypothyroidism patients. CRP levels were significantly higher in both hyperthyroid and hypothyroid patients as compared to the control group.

**Keywords:** Hypothyroidism, Hyperthyroidism, Thyroxine (T4) and Triiodothyronine (T3), CRP.

## INTRODUCTION

The thyroid gland is a vital glandular organ that produces essential hormones necessary for regulating metabolism, growth, and energy balance in the body (Al-Suhaimi *et al*., 2022). This gland secretes thyroxine (T4) and triiodothyronine (T3), two hormones that regulate growth, development, and metabolism, affecting almost all cells in the body (Aranda, 2025; Mariotti & Beck-Peccoz, 2021). The thyroid gland is a master energy regulator, controlling the basal metabolic rate, growth, development, and the functions of many body systems (Mundstock Dias *et al*., 2025). Located in the front of the neck, the thyroid gland grows with age and consists of hormone-producing follicles that become increasingly active over time (Tantawy *et al*., 2025). Thyroid function depends on a complex feedback system known as the hypothalamic-pituitary-thyroid axis, which maintains a delicate hormonal balance in the body. Thyroid dysfunction is primarily divided into two main categories: hyperthyroidism and hypothyroidism. These are common conditions with potentially serious health consequences, affecting the entire global population (Taylor *et al*., 2018; Wang *et al*., 2023).

Recent studies have confirmed that thyroid disorders are associated with characteristic changes in hematological and inflammatory markers, reflecting the systemic impact of hormonal imbalance. Systemic inflammation markers provide valuable and reliable information in patients with autoimmune thyroid diseases, such as Hashimoto's thyroiditis, where markers like the systemic inflammation index and the overall immune inflammation index are significantly higher compared to healthy individuals. Furthermore, C-reactive protein (CRP) is a biomarker for this systemic inflammation. Studies have shown a statistically significant increase in high-sensitivity C-reactive protein (hs-CRP) levels in patients with subclinical hypothyroidism, with a positive correlation between TSH levels and hs-CRP, making it a promising biomarker for assessing cardiovascular risk (Rajkarnikar *et al*.,2024; Mothilal *et al*., 2025).

# MATERIALS AND METHODS

This study was conducted between June and October 2025, were collected from hospitals and private laboratories in Salah al-Din. Ninety blood samples were collected from patients newly diagnosed with hyperthyroidism and hypothyroidism for both sex with different age groups. The present study divided to three groups, hypothyroidism (30), hyperthyroidism (30), and 30 healthy patients as control.

**Blood Sample Collection**

Under antiseptic conditions, 5 ml of venous blood samples were obtained. Serum was separated by inserting blood into a sterile 10 ml gel tube that was devoid of anticoagulant. After 30 minutes at laboratory temperature, the serum was extracted using an automated pipette and centrifuged at 2500 rpm for 10 minutes. The serum was securely sealed in three Eppendorf containers and stored at -20°C until it was required.

**Assessment of Biochemical Variable**

Both groups underwent testing for C-Reactive Protein (CRP) utilising (Sunlong- China) ELISA kits. Assess the content of Total Triiodothyronine (T3), and Total Thyroxine (T4) in blood serum utilising a pre-packaged assay kit supplied by VEDA.LAB-France.

**Statistical Analysis**

The SAS (2012) statistical analysis program was used to detect significant differences between the study groups.

# RESULT

As regarding to sex, the present study demonstrated non significant differences in the incidence of hypothyroidism and hyperthyroidism as compared with control at p-value 0.55. As shown in Table (1), Figure (1).

**Table 1: Cross-tabulation of Gender and Thyroid Condition with Chi-Square Test Results**

| Gender | Hyperthyroid | Hypothyroid | Control | Total |
|---|---|---|---|---|
| **Male** | 6 (6.7%) | 3 (3.3%) | 5 (5.6%) | **14 (15.6%)** |
| **Female** | 24 (26.7%) | 27 (30.0%) | 25 (27.8%) | **76 (84.4%)** |
| **Total** | **30 (33.3%)** | **30 (33.3%)** | **30 (33.3%)** | **90 (100%)** |
| **$\chi^2 = 1.18$** | **df = 2** | **p = 0.55 (Not significant)** | | |

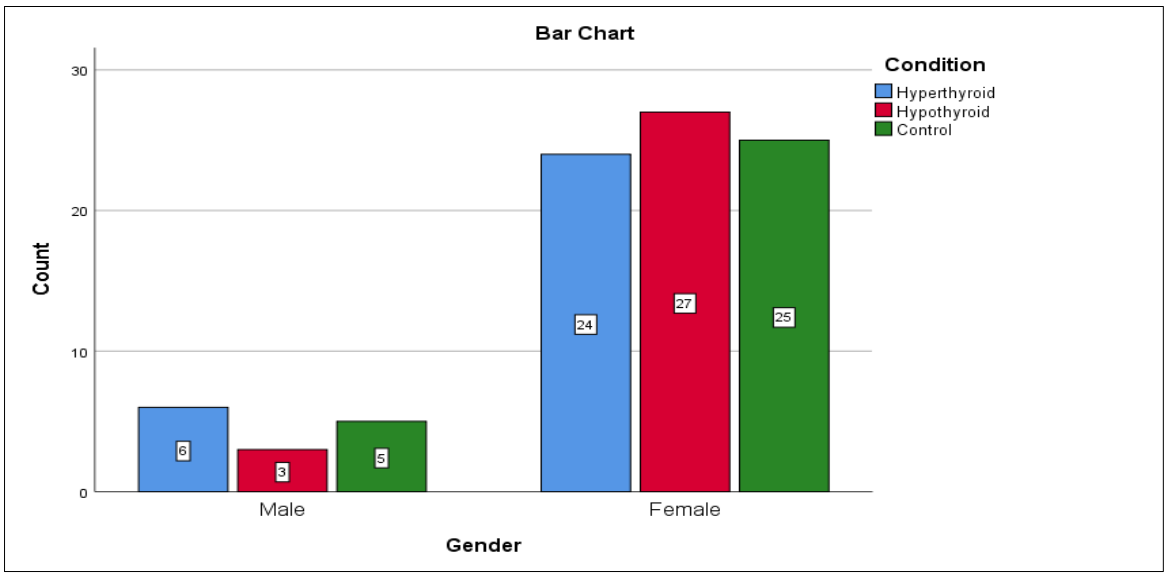


**Figure 1: Distribution of Thyroid Conditions by Gender**

Table (2) and Figure (2) illustrate the comparison of triiodothyronine (T3) levels among the three study groups. The mean T3 concentration was markedly elevated in the hyperthyroid group (4.5423 ± 1.9612 nmol/L) compared with both the control (1.7930 ± 0.5099 nmol/L) and hypothyroid (0.9490 ± 0.5108 nmol/L) groups. Analysis of variance (ANOVA) revealed a highly significant difference among groups ($F = 72.756$, $p < 0.001$).

**Table 2: Comparison of T3 Levels (nmol/L) among Study Groups**

| Group | Mean | SD | SE | F value | p value |
|---|---|---|---|---|---|
| Hyperthyroid | 4.5423 a | 1.9612 | 0.3581 | 72.756 | **< 0.001*** |
| Hypothyroid | 0.9490 c | 0.5108 | 0.0933 | | |
| Control | 1.7930 b | 0.5099 | 0.0931 | | |

**SD:** standard deviation, SE: Standard Error
Different letters are statistically different (pvalue < 0.05) using Duncan test.

**Table 2: Comparison of T3 Levels (nmol/L) among Study Groups**

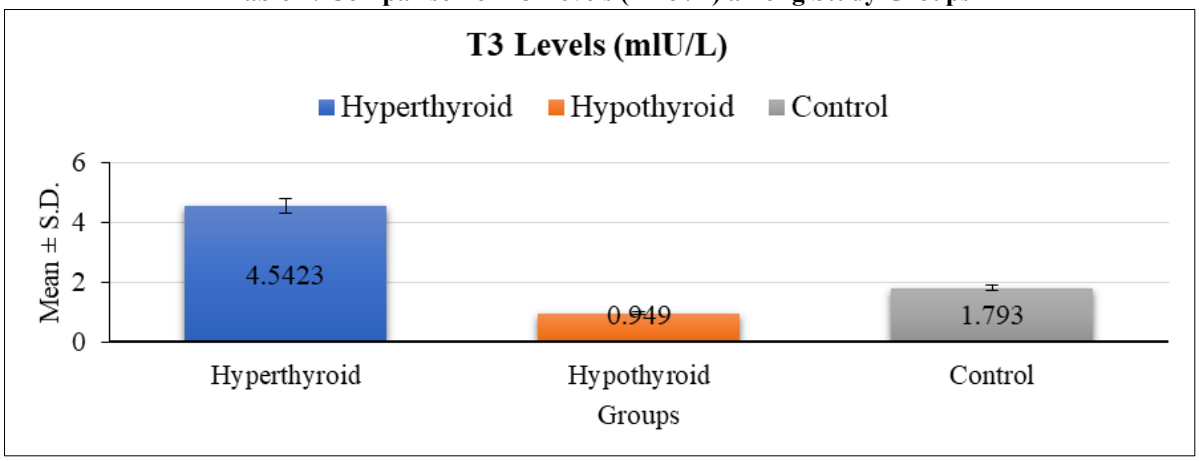


Table (3) and Figure (3) display the comparison of thyroxine (T4) levels among the hyperthyroid, hypothyroid, and control groups. The mean T4 concentration differed substantially across the groups, with the control group exhibiting the highest mean level hyperthyroid group (14.8757 ± 6.3775 µg/dL), followed by the control group (8.7698 ± 1.5734 µg/dL) and the hypothyroid group (5.4453 ± 2.3029 µg/dL). Analysis of variance (ANOVA) indicated a highly significant difference among the study groups (F = 42.503, p < 0.001), confirming strong statistical evidence of variation in T4 concentrations according to thyroid status.

**Table 3: Comparison of T4 Levels (µg/dL) among Study Groups**

| Group | Mean | SD | SE | F value | p value |
|---|---|---|---|---|---|
| Hyperthyroid | 14.8757 a | 6.3775 | 1.1644 | 42.503 | **< 0.001*** |
| Hypothyroid | 5.4453 c | 2.3029 | 0.4204 | | |
| Control | 8.7698 b | 1.5734 | 0.2791 | | |

**SD:** standard deviation, SE: Standard Error
Different letters are statistically different (pvalue < 0.05).

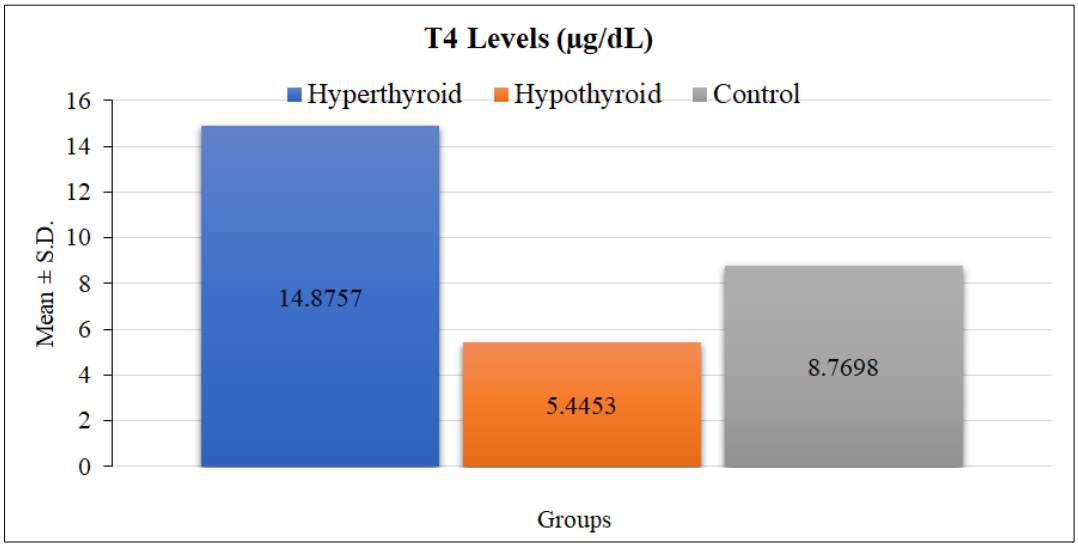


**Figure 3: Comparison of T4 Levels (µg/dL) among Study Groups**

The present study showed increase CRP level in hypothyroidism and hyperthyroidism as compared with control at p-value<< 0.001.

**Table 4: Comparison of CRP Levels (mg/dL) among Study Groups**

| Group | Mean | SD | SE | F value | p value |
|---|---|---|---|---|---|
| Hyperthyroid | 27.8667 a | 22.1199 | 4.0385 | 19.528 | **< 0.001*** |
| Hypothyroid | 24.0630 a | 23.0787 | 4.2136 | | |
| Control | 0.3813 b | 0.5196 | 0.0949 | | |

**SD:** standard deviation, SE: Standard Error
Different letters are statistically different (pvalue < 0.05).

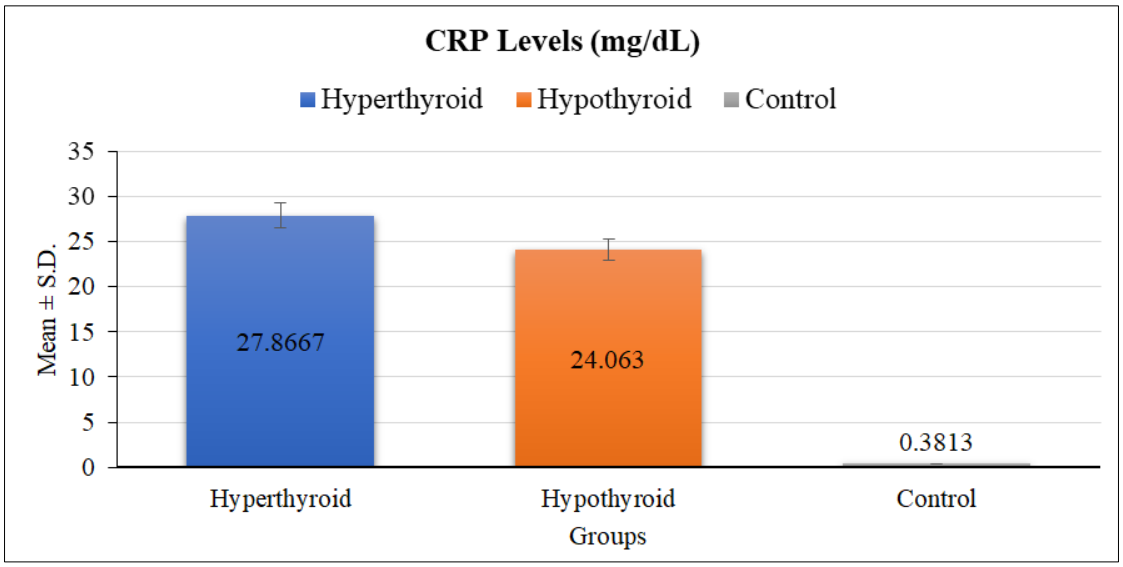


**Figure 4: Comparison of CRP Levels (mg/dL) among Study Groups**

## DISCUSSION

A study by (Chen *et al.*, 2020) observed non-significant differences between male and female. Likewise, some population surveys suggest that subclinical thyroid function abnormalities can occur similarly across sexes in certain age groups. It is widely documented that autoimmune thyroid disorders occur far more frequently in women. For example, a large hospital cohort in Oman found 67.5% of thyroid dysfunction cases were female versus 32.5% male (Marakala *et al.*, 2025). Similarly, national survey data from the U.S. reported that women had roughly double the prevalence of autoimmune thyroid disease compared to men (6.8% vs. 3.2% in 1988–1994, and 7.7% vs. 2.7% in 2007–2012) (Dillon *et al.*, 2025).

Triiodothyronine (T3) also showed a highly significant difference (P<0.001), with mean T3 highest in hyperthyroid patients and lowest in hypothyroid patients. The overt hyperthyroidism causes elevated serum T3 and T4, while hypothyroidism yields low levels of these hormones (Lee & Pearce, 2023). In autoimmune thyroiditis, both T3 and T4 typically fall. Thus, our observation that T3 significantly varied across groups is entirely in line with expectations and literature (Lee & Pearce, 2023).

Total thyroxine (T4) levels demonstrated a highly significant differences across study groups. The markedly reduced levels in hypothyroidism reflect impaired glandular synthesis and secretion (Klubo-Gwiezdzinska & Wartofsky, 2022). The comparatively higher T4 in hyperthyroid patients, despite elevated T3, may indicate preferential T3 secretion in certain etiologies (Luongo *et al.*, 2019). This dissociation between T3 and T4 levels highlights the importance of measuring both hormones alongside TSH for a comprehensive assessment, particularly when thyroid autonomy (Wang *et al.*, 2023). The result reinforces that T4 remains a cornerstone biomarker, essential for confirming and classifying the severity of thyroid dysfunction (Wang *et al.*, 2025).

CRP levels were significantly elevated in both hyperthyroid and hypothyroid group as compared to control group. The immune dysregulation and cytokine activation involved in thyroid dysfunction. Increased CRP reflects pro-inflammatory cytokine release (Ralli *et al*., 2020: Lee *et al*., 2022). Inflammation in hyperthyroidism may be attributable to autoimmune stimulation, or direct effects of thyrotoxicosis on hepatic acute-phase protein synthesis (Kar *et al*., 2020).

## CONCLUSION

The present study concluded increase T4, T3 in hyperthyroid patients, while decrease in hypothyroidism patients. CRP levels were significantly higher in both hyperthyroid and hypothyroid patients as compared to the control group.

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