

Comparative Assessment of Liver And Kidney Function Profiles in Patients With Hypothyroidism and Hyperthyroidism in An Indian Population

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Abstract

Background: Thyroid dysfunction can affect multiple organ systems, including the liver and kidneys. This study aimed to compare liver and kidney function profiles in patients with hypothyroidism and hyperthyroidism.

Methods: A hospital-based comparative cross-sectional study was conducted in the Department of Biochemistry, Sukh Sagar Medical College, Jabalpur, (M.P), India, from February 2026 to July 2026. A total of 130 adult patients were included, comprising 65 patients with hypothyroidism and 65 with hyperthyroidism. Thyroid function tests, liver function parameters, and kidney function parameters were estimated using standard laboratory methods. Correlation analysis was performed to assess the relationship between thyroid hormones and biochemical parameters.

Results: Females constituted 69.2% of the study population. The mean BMI was significantly higher in the hypothyroid group than in the hyperthyroid group (27.4 ± 4.6 vs. 23.8 ± 3.7 kg/m², $p < 0.001$). Hyperthyroid patients had significantly higher AST, ALP, GGT, total bilirubin, and direct bilirubin levels, while total protein and albumin were significantly lower. Hypothyroid patients showed significantly higher serum urea, creatinine, and BUN levels and lower eGFR ($p < 0.001$). TSH showed significant positive correlations with serum creatinine, urea, BUN, ALT, AST, and GGT and a negative correlation with eGFR. FT4 showed negative correlations with urea, creatinine, and BUN and a positive correlation with eGFR.

Conclusion: Hyperthyroidism was associated with greater alterations in selected liver function parameters, whereas hypothyroidism was associated with comparatively impaired renal function. Routine assessment of liver and kidney function may be useful in the clinical evaluation and monitoring of patients with thyroid disorders.

Keywords: Hypothyroidism; Hyperthyroidism; Thyroid function; Liver function; Kidney function; Creatinine; eGFR; TSH.

1. Introduction

Thyroid disorders are among the most common endocrine abnormalities encountered in clinical practice and represent an important public health concern in India.¹ Hypothyroidism and hyperthyroidism produce systemic metabolic and physiological changes because thyroid hormones regulate energy expenditure, protein synthesis, lipid and carbohydrate metabolism, cardiovascular function, and tissue oxygen consumption.^{2,3} Although the clinical manifestations of thyroid dysfunction are predominantly recognized through their effects on the cardiovascular, nervous, and metabolic systems, increasing evidence indicates that thyroid status also has a substantial influence on the functional integrity of other organs, particularly the liver and kidneys.⁴

The liver is central to thyroid hormone metabolism, including conjugation, deiodination, transport, and clearance of thyroid hormones.⁵ Conversely, thyroid hormones exert important effects on hepatocytes and regulate hepatic lipid oxidation, cholesterol metabolism, carbohydrate metabolism, mitochondrial activity, and energy homeostasis.⁶ Consequently, disturbances in thyroid hormone concentrations may result in biochemical abnormalities in liver function tests.⁷ In hypothyroidism, reduced thyroid hormone activity has been associated with impaired lipid metabolism, hepatic steatosis, dyslipidaemia, and alterations in serum aminotransferases. Hypothyroidism is also increasingly recognized as a potential contributor to metabolic dysfunction-associated steatotic liver disease (MASLD).⁸

Hyperthyroidism may cause abnormalities in liver function due to increased hepatic metabolism, oxidative stress, and, in severe cases, hepatic congestion secondary to high-output cardiac failure. Liver biochemical abnormalities, including changes in ALT, AST, ALP, bilirubin, and GGT, are frequently reported in untreated hyperthyroidism. A systematic review and meta-analysis found that approximately 55% of patients with untreated hyperthyroidism had at least one abnormal liver biochemical parameter.¹⁰ These abnormalities may result from thyroid hormone excess itself or, in some cases, from antithyroid drug therapy.¹⁰ Thyroid hormones play an important role in renal function by influencing renal blood flow, glomerular filtration,

Study Design and Study Setting:

The present study was a hospital-based comparative cross-sectional study conducted to assess and compare liver and kidney function profiles in patients with hypothyroidism and hyperthyroidism. The study was carried out in the Department of Biochemistry, at Sukh Sagar Medical College, M.P, India, during the period from February 2026 to July 2026.

Patients diagnosed with hypothyroidism or hyperthyroidism and fulfilling the predefined eligibility criteria were recruited for the study. The diagnosis of thyroid dysfunction was established on the basis of clinical findings and thyroid function test results.

Study Population

The study included adult patients diagnosed with either hypothyroidism or hyperthyroidism. Based on their thyroid status, participants were divided into two groups:

Group I: Patients with hypothyroidism.

Group II: Patients with hyperthyroidism.

The thyroid status of each participant was confirmed by estimation of serum thyroid-stimulating hormone (TSH), free triiodothyronine (FT3), and free thyroxine (FT4).

Inclusion Criteria:

1. Adult patients aged 18 years and above.
2. Patients diagnosed with primary hypothyroidism or primary hyperthyroidism.
3. Patients with thyroid dysfunction confirmed by thyroid function tests.
4. Patients willing to participate in the study.
5. Patients who provided written informed consent.

Exclusion Criteria:

1. Known chronic liver disease or cirrhosis.
2. Known chronic kidney disease or renal failure.
3. Acute kidney injury.
4. Viral hepatitis or other active hepatic disease.
5. Diabetes mellitus, where considered a significant confounding factor.
6. Severe cardiovascular disease or congestive heart failure.
7. Acute infection or severe systemic illness.
8. Malignancy, Pregnancy.
9. History of significant alcohol consumption.
10. Patients receiving medications known to significantly affect liver or kidney function.
11. Patients unwilling to provide informed consent.

Sample Size:

A total of total 130 participants were included in the study, comprising (n=65) patients with hypothyroidism and (n=65) patients with hyperthyroidism.

Sample-size calculation using the recent prevalence

Using:

- Prevalence (p) = 9.3% = 0.093
- $q = 1 - 0.093 = 0.907$
- 95% confidence level $\rightarrow Z = 1.96$
- Absolute precision (d) = 5% = 0.05

So, the minimum sample size is approximately 130 participants.

Adding 10% for incomplete data/non-response:

Clinical and Demographic Data

Relevant demographic and clinical information were collected using a structured proforma. Information regarding age, sex, duration of thyroid disease, treatment history, relevant medical history, and associated comorbidities was recorded. Height and weight were measured using standard procedures, and body mass index (BMI) was calculated as weight in kilograms divided by height in metres squared.

Sample Collection

Approximately 5 mL of venous blood was collected from each participant under aseptic precautions. Participants were preferably instructed to undergo overnight fasting before blood collection.

The collected blood samples were allowed to clot and subsequently centrifuged according to standard laboratory procedures. Serum was separated and used for estimation of thyroid function tests, liver function tests, and renal function parameters.

All samples were processed using standardized procedures, and appropriate precautions were taken to avoid haemolysis and other pre-analytical errors.

Estimation of Thyroid Function Tests

Thyroid function was assessed by measuring serum:

- Thyroid-stimulating hormone (TSH)
- Free triiodothyronine (FT3)
- Free thyroxine (FT4)

The parameters were estimated using an automated immunoassay analyzer with commercially available reagent kits according to the manufacturer's instructions.

Patients were categorized as hypothyroid or hyperthyroid based on their clinical diagnosis and thyroid function test results using the reference ranges established by the laboratory.

Assessment of Liver Function

Liver function was assessed by estimation of the following biochemical parameters:

- Alanine aminotransferase (ALT)
- Aspartate aminotransferase (AST)
- Alkaline phosphatase (ALP)
- Gamma-glutamyl transferase (GGT)
- Total bilirubin
- Direct bilirubin
- Total protein
- Albumin

ALT and AST were estimated using standardized enzymatic methods. ALP and GGT were estimated using appropriate kinetic methods. Total and direct bilirubin were estimated using standard colorimetric methods. Serum total protein and albumin were estimated using standard biochemical methods.

Assessment of Kidney Function

Renal function was assessed by estimation of:

- Serum creatinine
- Serum urea
- Blood urea nitrogen (BUN), where applicable
- Estimated glomerular filtration rate (eGFR)

Serum creatinine was estimated using a standardized biochemical method, while serum urea was estimated by the urease-based method.

The estimated glomerular filtration rate was calculated from serum creatinine using the appropriate validated eGFR equation and expressed as mL/min/1.73 m².

Study Variables:

The primary independent variable was thyroid status, categorized as hypothyroidism or hyperthyroidism. The primary outcome variables were liver and kidney function parameters.

Liver function parameters: ALT, AST, ALP, GGT, total bilirubin, direct bilirubin, total protein, and albumin.

Kidney function parameters: serum creatinine, serum urea, BUN, and eGFR.

Age, sex, BMI, duration of thyroid disease, treatment status, and relevant comorbidities were considered potential confounding variables.

Result:

Table 1: Distribution of Participants According to Thyroid Status

Group	Number (n)	Percentage (%)
Hypothyroidism	65	50.0
Hyperthyroidism	65	50.0
Total	130	100.0

The study included 130 participants, with an equal distribution of 65 (50.0%) patients with hypothyroidism and 65 (50.0%) patients with hyperthyroidism.

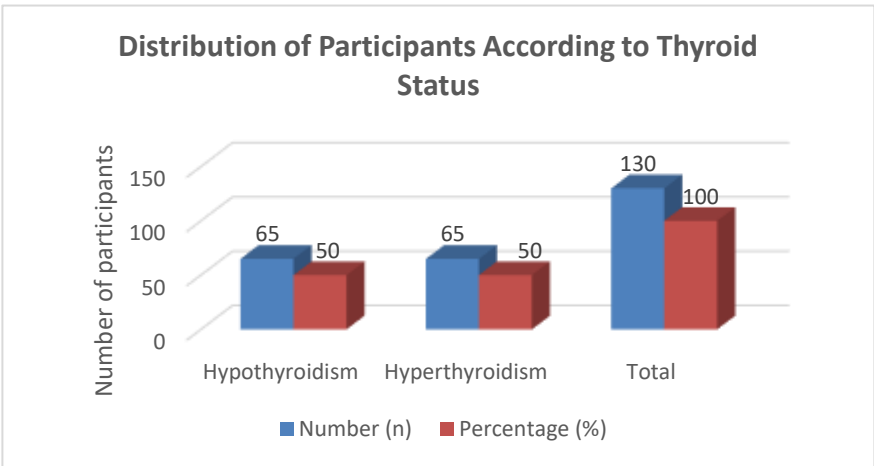


Fig: 1 Graphical Represents Distribution of Participants According to Thyroid Status

Table 2. Gender-wise Distribution of Study Participants

Gender	Hypothyroidism (n)	(%)	Hyperthyroidism (n)	(%)	Total (n)	(%)
Male	17	26.2	23	35.4	40	30.8
Female	48	73.8	42	64.6	90	69.2
Total	65	100	65	100	130	100

Females predominated in both groups, comprising 73.8% of the hypothyroid group and 64.6% of the hyperthyroid group. Males accounted for 26.2% and 35.4%, respectively. Overall, females represented 69.2% of the study population.

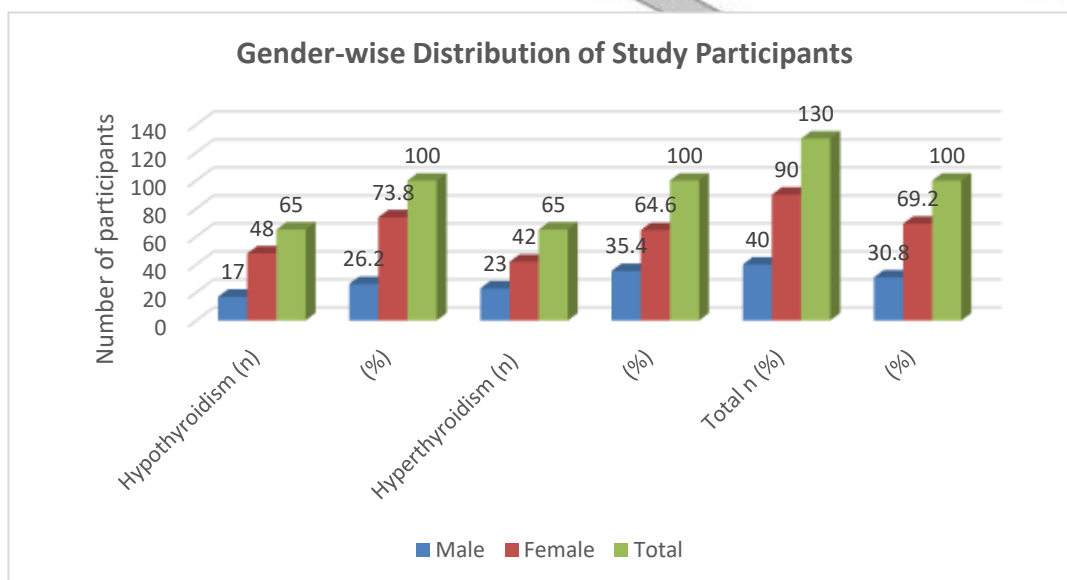


Fig: 2 Graphical Represents Gender-wise Distribution of Study Participants

Table 3. Age-wise Distribution of Study Participant

Age group (years)	Hypothyroidism n	(%)	Hyperthyroidism (n)	(%)	Total (n)	(%)
18–29	8	12	14	21	22	17
30–39	18	28	23	35	41	31
40–49	21	32	16	25	37	29
50–59	12	19	8	13	20	15
≥60	6	9	4	6	10	8
Total	65	100	65	100	130	100

The majority of participants were in the 30–39 years age group (31%), followed by the 40–49 years age group (29%). The lowest proportion was observed in participants aged ≥60 years (8%). Overall, the age distribution was relatively comparable between the hypothyroidism and hyperthyroidism groups.

Table 4. Comparison of Age Between Hypothyroid and Hyperthyroid Groups

Parameter	Hypothyroidism (n=65)	Hyperthyroidism (n=65)	p-value
Age (years), Mean ± SD	43.8 ± 11.2	38.9 ± 11.0	0.014

The mean age of participants was 43.8 ± 11.2 years in the hypothyroid group and 38.9 ± 11.0 years in the hyperthyroid group. The mean age was significantly higher among patients with hypothyroidism ($p = 0.014$).

Table 5. BMI-wise Distribution of Study Participants.

BMI category (kg/m ²)	Hypothyroidism n	(%)	Hyperthyroidism n	(%)	Total n (%)
<18.5	2	3.1	8	12.3	10 (7.7)
18.5–24.9	20	30.8	34	52.3	54 (41.5)
25.0–29.9	27	41.5	18	27.7	45 (34.6)
≥30.0	16	24.6	5	7.7	21 (16.2)
Total	65	100	65	100	130 (100)

Most participants had a normal BMI (18.5–24.9 kg/m²), accounting for 41.5% of the total study population. Overweight and obesity were more common in the hypothyroidism group, with 41.5% overweight and 24.6% obese, compared with 27.7% and 7.7%, respectively, in the hyperthyroidism group. Underweight was more frequent among hyperthyroid patients (12.3%).

Table 6. Comparison of BMI Between Hypothyroid and Hyperthyroid Groups

Parameter	Hypothyroidism (n=65)	Hyperthyroidism (n=65)	p-value
BMI (kg/m ²), Mean ± SD	27.4 ± 4.6	23.8 ± 3.7	<0.001

The mean BMI was significantly higher in patients with hypothyroidism (27.4 ± 4.6 kg/m²) than in patients with hyperthyroidism (23.8 ± 3.7 kg/m²; $p < 0.001$).

Table 7. Comparison of Thyroid Function Parameters

Parameter	Hypothyroidism (n=65)	Hyperthyroidism (n=65)	p-value
TSH (μIU/mL)	14.82 ± 7.64	0.08 ± 0.05	<0.001
FT3 (pg/mL)	2.21 ± 0.49	5.84 ± 1.31	<0.001
FT4 (ng/dL)	0.71 ± 0.18	2.42 ± 0.72	<0.001

A marked difference in thyroid function parameters was observed between the two groups. Serum TSH was substantially higher in the hypothyroid group, whereas FT3 and FT4 were significantly higher in the hyperthyroid group. All three thyroid parameters showed statistically significant differences between the groups ($p < 0.001$).

Table 8. Comparison of Liver Enzymes Between Hypothyroid and Hyperthyroid Groups

Parameter	Hypothyroidism Mean ± SD	Hyperthyroidism Mean ± SD	p-value
ALT (U/L)	42.6 ± 18.4	48.7 ± 22.1	0.096
AST (U/L)	37.8 ± 15.2	43.9 ± 18.6	0.041
ALP (U/L)	118.5 ± 34.7	132.8 ± 41.5	0.032
GGT (U/L)	39.4 ± 21.5	48.6 ± 27.4	0.034

Serum ALT, AST, ALP, and GGT levels were higher in the hyperthyroid group compared with the hypothyroid group. The

differences in AST, ALP, and GGT were statistically significant ($p < 0.05$), whereas the difference in ALT was not statistically significant.

Table 9. Comparison of Bilirubin, Total Protein and Albumin

Parameter	Hypothyroidism Mean $\pm$ SD	Hyperthyroidism Mean $\pm$ SD	<i>p</i> -value
Total bilirubin (mg/dL)	0.82 $\pm$ 0.25	1.01 $\pm$ 0.36	<0.001
Direct bilirubin (mg/dL)	0.23 $\pm$ 0.09	0.29 $\pm$ 0.12	0.002
Total protein (g/dL)	7.08 $\pm$ 0.52	6.82 $\pm$ 0.56	0.008
Albumin (g/dL)	4.08 $\pm$ 0.37	3.89 $\pm$ 0.42	0.006

Total and direct bilirubin concentrations were significantly higher in the hyperthyroid group. Conversely, serum total protein and albumin levels were significantly lower in patients with hyperthyroidism compared with patients with hypothyroidism.

Table 10. Comparison of Kidney Function Parameters.

Parameter	Hypothyroidism Mean $\pm$ SD	Hyperthyroidism Mean $\pm$ SD	<i>p</i> -value
Serum urea (mg/dL)	39.8 $\pm$ 11.4	29.7 $\pm$ 8.6	<0.001
Serum creatinine (mg/dL)	1.12 $\pm$ 0.31	0.82 $\pm$ 0.20	<0.001
BUN (mg/dL)	18.6 $\pm$ 5.4	13.9 $\pm$ 4.1	<0.001
eGFR (mL/min/1.73 m ²)	74.8 $\pm$ 15.6	91.2 $\pm$ 13.8	<0.001

Patients with hypothyroidism demonstrated higher serum urea, creatinine, and BUN concentrations compared with patients with hyperthyroidism. The mean eGFR was lower in the hypothyroid group (74.8 $\pm$ 15.6 mL/min/1.73 m²) than in the hyperthyroid group (91.2 $\pm$ 13.8 mL/min/1.73 m²). All renal parameters showed statistically significant differences between the groups ($p < 0.001$).

Table 11. Correlation of Thyroid Function Parameters With Liver and Kidney Function Parameters

Thyroid parameter	Liver/Kidney parameter	Correlation coefficient (r)	<i>p</i> -value
TSH	ALT	+0.31	0.013*
TSH	AST	+0.34	0.006*
TSH	ALP	+0.22	0.075
TSH	GGT	+0.29	0.019*
TSH	Total bilirubin	+0.18	0.151
TSH	Albumin	-0.27	0.029*
TSH	Serum urea	+0.36	0.003*
TSH	Serum creatinine	+0.42	<0.001**
TSH	BUN	+0.37	0.002*
TSH	eGFR	-0.39	0.001*
FT4	Serum urea	-0.28	0.023*
FT4	Serum creatinine	-0.32	0.009*
FT4	BUN	-0.29	0.018*

FT4	eGFR	+0.35	0.004*
Note: $p < 0.05$ = statistically significant (*); $p < 0.001$ = highly significant (**).			

Correlation analysis showed that TSH had significant positive correlations with ALT, AST, GGT, serum urea, creatinine, and BUN, and significant negative correlations with albumin and eGFR. FT4 showed significant negative correlations with serum urea, creatinine, and BUN and a positive correlation with eGFR. Overall, higher TSH and lower FT4 were associated with poorer hepatic and renal function. A p-value < 0.05 was considered statistically significant.

Table 12. Overall Comparison of Liver and Kidney Function Parameters

Parameter	Hypothyroidism Mean $\pm$ SD	Hyperthyroidism Mean $\pm$ SD	p-value
ALT (U/L)	42.6 $\pm$ 18.4	48.7 $\pm$ 22.1	0.096
AST (U/L)	37.8 $\pm$ 15.2	43.9 $\pm$ 18.6	0.041*
ALP (U/L)	118.5 $\pm$ 34.7	132.8 $\pm$ 41.5	0.032*
GGT (U/L)	39.4 $\pm$ 21.5	48.6 $\pm$ 27.4	0.034*
Total bilirubin (mg/dL)	0.82 $\pm$ 0.25	1.01 $\pm$ 0.36	$< 0.001^{**}$
Direct bilirubin (mg/dL)	0.23 $\pm$ 0.09	0.29 $\pm$ 0.12	0.002*
Total protein (g/dL)	7.08 $\pm$ 0.52	6.82 $\pm$ 0.56	0.008*
Albumin (g/dL)	4.08 $\pm$ 0.37	3.89 $\pm$ 0.42	0.006*
Urea (mg/dL)	39.8 $\pm$ 11.4	29.7 $\pm$ 8.6	$< 0.001^{**}$
Creatinine (mg/dL)	1.12 $\pm$ 0.31	0.82 $\pm$ 0.20	$< 0.001^{**}$
BUN (mg/dL)	18.6 $\pm$ 5.4	13.9 $\pm$ 4.1	$< 0.001^{**}$
eGFR (mL/min/1.73 m ²)	74.8 $\pm$ 15.6	91.2 $\pm$ 13.8	$< 0.001^{**}$

The hyperthyroid group showed higher ALT, AST, ALP, GGT, and bilirubin levels compared with the hypothyroid group, with significant differences in AST, ALP, GGT, and bilirubin. Total protein and albumin were significantly lower in hyperthyroidism. In contrast, the hypothyroid group showed significantly higher urea, creatinine, and BUN levels and significantly lower eGFR, indicating comparatively reduced renal function.

Discussion

The present study compared liver and kidney function profiles among 130 patients, comprising 65 patients with hypothyroidism and 65 patients with hyperthyroidism. Females predominated in both groups, and the mean BMI was significantly higher in the hypothyroid group. Hyperthyroid patients showed significantly higher AST, ALP, GGT, and bilirubin levels compared with hypothyroid patients, which is consistent with previous studies reporting frequent liver biochemical abnormalities in hyperthyroidism. In contrast, hypothyroid patients showed significantly higher serum urea, creatinine, and BUN levels and significantly lower eGFR, supporting previous evidence of impaired renal function in hypothyroidism. Correlation analysis showed that higher TSH was associated with increased serum creatinine and reduced eGFR, whereas higher FT4 was associated with better renal function. Overall, the present findings indicate that hyperthyroidism was associated with greater alterations in selected liver function parameters, whereas hypothyroidism was associated with comparatively poorer renal function. Since the study was cross-sectional, the observed relationships indicate associations and cannot establish causality.

CONCLUSION

The present study demonstrated significant differences in liver and kidney function profiles between patients with hypothyroidism and hyperthyroidism. Hyperthyroid patients showed higher levels of AST, ALP, GGT, and bilirubin, indicating greater alterations in selected liver function parameters. In contrast, hypothyroid patients showed higher serum urea, creatinine, and BUN levels with

lower eGFR, suggesting comparatively impaired renal function. Correlation analysis further demonstrated an association between thyroid function and renal parameters. Overall, the findings highlight the importance of routine assessment of liver and kidney function in patients with thyroid disorders for early detection and appropriate clinical management.

Conflict of Interest: The authors declare that there is no conflict of interest related to this study.

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