International Journal of Current Pharmaceutical Research

ISSN- 0975-7066 Vol 17, Issue 6, 2025

Original Article

BIOCHEMICAL ALTERATIONS IN MUSCLE AND RENAL MARKERS IN THYROID DISEASE: A CROSS-SECTIONAL STUDY

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Received: 12 Aug 2025, Revised and Accepted: 02 Oct 2025

ABSTRACT

Objective: The study aimed to assess and compare serum levels of CK, LDH, and creatinine in patients with hypothyroidism and hyperthyroidism with those in euthyroid (healthy) controls, to elucidate the metabolic alterations and their clinical relevance.

Methods: This was a hospital-based cross-sectional study conducted on 90 participants, divided into three groups: Group I: 30 patients with hypothyroidism, Group II: 30 patients with hyperthyroidism, and Group III: 30 age-and sex-matched healthy controls. Fasting venous blood samples were analyzed for CK, LDH, and serum creatinine using standard enzymatic colorimetric methods.

Results: CK and LDH levels were significantly elevated in hypothyroid patients compared to controls ($p<0.001$), reflecting subclinical myopathy. In contrast, hyperthyroid patients showed moderately elevated LDH but not CK. Serum creatinine levels were higher in hypothyroidism and lower in hyperthyroidism compared to controls, suggesting thyroid state-dependent renal function modulation. Pearson correlation showed a negative correlation between TSH and eGFR**,** and a positive correlation between TSH and CK levels in hypothyroid subjects.

Conclusion: Thyroid dysfunction significantly alters muscle and renal biomarkers. Routine assessment of CK, LDH, and serum creatinine can aid in early detection of subclinical myopathy and renal involvement in thyroid patients. This may provide insights for better metabolic monitoring and management of thyroid disorders.

Keywords: Thyroid dysfunction, Creatine kinase, Lactate dehydrogenase, Hypothyroidism, and Serum creatinine

DOI: https://dx.doi.org/10.22159/ijcpr.2025v17i6.7082 Journal homepage: https://innovareacademics.in/journals/index.php/ijcpr

INTRODUCTION

The thyroid gland is a small endocrine organ located anterior to the trachea, produces two main hormones: thyroxine (T4) and triiodothyronine (T3), both of which play a pivotal role in regulating basal metabolic rate, thermogenesis, cardiovascular function, neural development, and numerous metabolic pathways [1]. Thyroid hormones influence almost every organ system in the body, including the muscular and renal systems. Their excess or deficiency leads to clinical conditions broadly categorized as hyperthyroidism and hypothyroidism [2].

These conditions affect not only hormonal balance but also manifest with a spectrum of biochemical and physiological abnormalities, many of which often go unnoticed or misattributed. Among these are changes in muscle and renal function markers, particularly Creatine Kinase (CK), Lactate Dehydrogenase (LDH), and serum creatinine, which reflect the metabolic and structural integrity of muscle and kidney tissue [3].

CK is an enzyme present in high concentrations in skeletal muscle, myocardium, and brain tissue, catalyzing the conversion of creatine and ATP to phosphocreatine and ADP. It serves as an energy buffer in tissues with high fluctuating energy demands [4]. LDH is an another key enzyme that catalyzes the interconversion of pyruvate and lactate during anaerobic glycolysis and is found in various tissues, including liver, heart, muscles, and red blood cells [5].

Thyroid hormones modulate mitochondrial oxidative phosphorylation and membrane integrity. Hypothyroidism may lead to mitochondrial dysfunction, reduced ATP production, and consequent leakage of CK and LDH into the bloodstream [6]. In hyperthyroidism, the heightened metabolic state accelerates protein turnover and increases muscle catabolism without significant muscle enzyme elevation unless myopathy develops [7].

Serum creatinine is a by-product of muscle metabolism which is widely used as a marker of renal function. It is produced at a relatively constant rate in healthy individuals and is excreted by glomerular filtration [8]. Thyroid dysfunction affects renal physiology by altering renal blood flow (RBF) and glomerular filtration rate (GFR). In hypothyroidism, reduced cardiac output and renal perfusion lead to decreased GFR and elevated serum creatinine. In contrast, hyperthyroidism enhances RBF and GFR by lowering the creatinine levels. This relationship underlines the complex thyroid-kidney axis which remains underappreciated in clinical evaluations. In hyperthyroidism, muscle weakness is a hallmark; enzyme levels may be deceptively normal or low due to rapid clearance [9, 10].

Several studies have investigated the impact of thyroid hormones on muscle and renal function, but many are limited by small sample sizes, non-uniform populations, and lack of control groups. A number of studies report elevated CK levels in hypothyroid patients, which tend to normalize with thyroxine therapy. However, the extent of correlation with thyroid hormone levels, particularly TSH, remains inconsistent. LDH elevations have been observed in both hypo-and hyperthyroid states but lack clear diagnostic thresholds.

Similarly, although studies have shown that hypothyroid patients often have elevated serum creatinine with reduced GFR, and hyperthyroid patients have low creatinine due to increased renal clearance, there is no unified clinical protocol recommending renal function testing in all thyroid patients.

The primary objective is to evaluate serum CK, LDH, and creatinine levels in diagnosed cases of hypothyroidism and hyperthyroidism and compare them with euthyroid controls. The study also aims to explore correlations between thyroid hormone levels (TSH, FT3, FT4) and these biochemical markers to understand the pathophysiological implications.

MATERIALS AND METHODS

Source of data and study design

This was a hospital-based cross-sectional comparative study conducted in the Department of Biochemistry in collaboration with

the Department of Medicine at Dr. Ulhas Patil Medical College and Hospital, Jalgaon (Maharashtra). Samples were analyzed for biochemical investigations in the Department of Biochemistry, Dr. Ulhas Patil Medical College and Hospital, Jalgaon (Maharashtra).

Study population: A total of 90 subjects were enrolled and divided into three groups:

- **Group I:** 30 patients diagnosed with hypothyroidism
- **Group II:** 30 patients diagnosed with hyperthyroidism
- **Group III:** 30 age-and sex-matched euthyroid healthy controls

Patients were selected based on predefined inclusion and exclusion criteria.

Inclusion criteria

- Adults aged 18–60 y.
- Newly diagnosed and untreated cases of Primary hypothyroidism and Primary hyperthyroidism.
- Controls with normal TSH, FT3, and FT4 levels.

Exclusion criteria

- Patients with known muscle disorders (e. g., muscular dystrophies, polymyositis).
- History of chronic kidney disease (CKD), diabetes mellitus, liver disease, or cardiovascular disease.
- Use of medications that influence muscle or renal function (e. g., statins, steroids, ACE inhibitors).
- Pregnant or lactating women.
- Recent infections or surgery within the last 2 mo.

Sample collection

Fasting venous blood samples (5 ml) were collected from each participant under aseptic precautions. Samples were allowed to clot and then centrifuged at 3000 rpm for 10 min to separate serum.

- **Thyroid function tests (TSH, FT3, FT4)** were analyzed using chemiluminescence immunoassay (CLIA).
- **Serum Creatine Kinase (CK)** and **lactate dehydrogenase (LDH)** levels were measured using standard enzymatic colorimetric methods on an automated biochemistry analyzer.
- **Serum creatinine** was estimated using the Jaffe's kinetic method.

Statistical analysis

Mean and standard deviation were used to determine the data. Intergroup comparisons were made using ANOVA**.** Pearson correlation coefficient (r) was used to evaluate the relationships between thyroid hormones and biochemical markers. A p-value less than 0.05 were considered statistically significant.

RESULTS

The study included 90 subjects of age group of 18 to 60 y and divided into 3 groups: Hypothyroidism, Hyperthyroidism and Healthy Controls. Table 1 shows significantly elevated levels of Creatine Kinase (CK) in hypothyroid patients compared to controls ($p<0.01$). Hyperthyroid patients showed moderately higher levels than controls, but less than hypothyroids. It also shows high level in hypothyroid group, followed by hyperthyroid, with lowest values in controls. There is also increased level in hypothyroid group, decreased in hyperthyroid patients compared to controls, indicating altered renal perfusion dynamics.

Table 1: Shows comparison of biochemical parameters among study groups

Biochemical parameters	Hypothyroid (n = 30)	Hyperthyroid (n = 30)	Control (n = 30)	ANOVA
Creatine kinase (U/l)	198.00±36.5	122.00±28.4	102.00±25.1	<0.001
Lactate dehydrogenase (U/l)	345.00±42.7	310.00±33.9	270.00±31.4	<0.01
Serum creatinine (mg/dl)	1.28±0.19	0.68±0.12	0.85±0.14	<0.01

Table 2: Shows correlation of thyroid hormones with biochemical parameters

Thyroid hormone	Biochemical marker	Correlation coefficient (r)	P-value
TSH	Creatine Kinase (CK)	+0.52	<0.01
TSH	Lactate Dehydrogenase (LDH)	+0.46	<0.05
TSH	Serum Creatinine	+0.49	<0.01
FT3	Creatine Kinase (CK)	−0.43	<0.05
FT3	Lactate Dehydrogenase (LDH)	−0.40	<0.05
FT3	Serum Creatinine	−0.56	<0.01
FT4	Creatine Kinase (CK)	−0.45	<0.05
FT4	Lactate Dehydrogenase (LDH)	−0.38	<0.05
FT4	Serum Creatinine	−0.51	<0.01

Not significant ($p>0.05$) and highly significant ($p<0.001$)

Table 2 shows that TSH is positively correlated with CK, LDH, and serum creatinine-higher TSH (suggesting hypothyroidism) is associated with higher levels of these biochemical markers. FT3 and FT4 show negative correlations consistent with hyperthyroid physiology**,** where increased hormone levels lead to reduced CK and creatinine due to enhanced clearance and lower muscle injury.

DISCUSSION

Thyroid hormones are pivotal regulators of metabolic activity, influencing numerous organ systems including the muscular and renal systems. The current study aimed to assess serum levels of Creatine Kinase (CK), Lactate Dehydrogenase (LDH), and serum creatinine in patients with hypothyroidism and hyperthyroidism and compare them with healthy euthyroid controls. Our findings highlight that thyroid dysfunction significantly alters the levels of these biomarkers, suggesting both clinical and subclinical effects on muscle integrity and renal physiology.

Elevation in serum CK reflects muscle injury, reduced clearance, or increased membrane permeability. In this study, mean CK levels were significantly elevated in hypothyroid patients (198 U/l) as compared to hyperthyroid (122 U/l) and control subjects (102 U/l). This observation is supported by earlier study by Chaudhary *et al.* (2013), which reported similar enzyme elevations in hypothyroidism [11]. Khaleeli *et al.* (1983) also reported CK elevation as a common finding in hypothyroid myopathy, often reversible with thyroxine therapy [12].

The positive correlation between TSH and CK ($r = +0.52$, $p<0.01$) indicates that as thyroid function declines (TSH rises), muscle injury or enzyme leakage increases. This may be attributed to

mitochondrial dysfunction and impaired oxidative metabolism in skeletal muscle, leading to energy starvation, myofiber damage, and increased permeability of sarcolemma. These subclinical myopathic changes present with symptoms like muscle cramps, stiffness, and generalized fatigue are the hallmarks of hypothyroidism [13].

In contrast, CK levels were not significantly elevated in hyperthyroidism. This aligns with the fact that hyperthyroid myopathy is largely catabolic and often does not present with myonecrosis, explaining the relative absence of CK elevation. While some studies report mild CK increases in hyperthyroidism, these are usually within the upper normal range and clinically insignificant.

LDH is an intracellular enzyme involved in glycolysis was also elevated in thyroid dysfunction. Our study showed LDH levels highest in hypothyroid patients (345 U/l), followed by hyperthyroid (310 U/l) and controls (270 U/l). The elevation of LDH in both conditions in hypothyroidism reflects a state of systemic metabolic disturbance.

The positive correlation between TSH and LDH ($r = +0.46$, $p<0.05$) supports impaired thyroid function may affect not only muscle but also other organs expressing LDH. Thyroid hormones modulate anaerobic metabolism and oxidative phosphorylation, and their deficiency leads to cellular energy imbalance, possibly triggering LDH release from stressed or damaged tissues [14].

In hyperthyroid patients, the elevated LDH may be attributed to increased cellular and muscle catabolism. Hyperthyroidism accelerates metabolic activity and can result in skeletal muscle wasting, explaining the enzyme leak, although CK is not elevated due to enhanced enzyme clearance and absence of true muscle necrosis [15].

Our study found elevated serum creatinine in hypothyroid patients (1.28 mg/dl) compared to hyperthyroid (0.68 mg/dl) and controls (0.85 mg/dl), which is in line with the findings from Iglesias *et al.* (2006) and Kaptein *et al.* (1996) [16, 17]. Biondi *et al.* (2008) observed similar changes in serum creatinine in thyroid disorders and emphasized that misinterpretation may lead to overdiagnosis of renal insufficiency [18].

The positive correlation between TSH and creatinine ($r = +0.49$, $p<0.01$) and the negative correlation with FT3 and FT4 suggest that as thyroid function worsens, renal clearance diminishes. Hypothyroidism reduces cardiac output and renal perfusion by lowering GFR and increasing serum creatinine. Additionally, hypothyroidism can increase creatinine production due to muscle damage [19].

In contrast, hyperthyroidism enhances renal plasma flow and GFR, leading to reduced serum creatinine levels. However, this may not reflect true renal function improvement; rather, it's a hyper filtration state. Importantly, low creatinine in hyperthyroid patients with muscle wasting may also result from reduced muscle mass, complicating the interpretation of kidney function in these individuals [20, 21].

The above data clearly indicate that hypothyroidism is more likely to cause elevations in all three biomarkers, consistent with hypometabolism, reduced clearance, and potential tissue injury. Hyperthyroidism not affect CK significantly influenced LDH and creatinine levels due to accelerated metabolism and catabolism.

These findings have several important clinical implications such as subclinical myopathy detection, renal function misinterpretation, monitoring treatment response, and prevention from further complications. The limitation of the present study is that there is lack of eGFR calculation and no electromyography (EMG) or muscle biopsy are performed to confirm myopathy.

CONCLUSION

Our findings demonstrated that hypothyroid patients exhibit significantly elevated levels of CK and LDH**,** indicating subclinical or overt myopathic involvement. Elevated CK was strongly correlated with TSH levels, supporting the hypothesis that muscle membrane stability and energy metabolism are impaired in hypothyroid states. Similarly, LDH levels were increased, reflecting a broader metabolic stress response in multiple tissues, not limited to muscle alone. Serum creatinine levels were elevated in hypothyroid individuals due to reduced renal plasma flow and glomerular filtration rate (GFR).

The relationship between thyroid function and systemic biomarkers such as CK, LDH, and serum creatinine underscores the multi-systemic impact of thyroid diseases. The assessment of these markers should be encouraged in the routine evaluation of thyroid patients to facilitate early detection of complications, guide clinical management, and improve overall outcomes.

FUNDING

Nil

AUTHORS CONTRIBUTIONS

All authors have contributed equally

CONFLICT OF INTERESTS

Declared none

REFERENCES

1. Nayak B, Burman K. Thyrotoxicosis and hyperthyroidism. Med Clin North Am. 2012;96(2):245-60.
2. Cooper DS. Clinical practice. Subclinical hypothyroidism. N Engl J Med. 2001;345(4):260-5. doi: 10.1056/NEJM200107263450406, PMID 11474665.
3. Kamath C, Raghupathi K, Bhat R. A study of creatine kinase lactate dehydrogenase activity and serum creatinine in thyroid dysfunction. Int J Health Sci Res. 2020;10(2):79-84.
4. Peixoto De Miranda EJ, Rodrigues FF, Pereira RM. Muscle enzymes in hypothyroidism: an overview. Arq Bras Endocrinol Metab. 2010;54(5):405-12.
5. Palaniappan M, Sundararajan P, Panneerselvam S. Study of serum CK and LDH levels in hypothyroid patients. Int J Adv Med. 2017;4(3):648-52.
6. Tseng FY, Lin WY, Lin CC, Lee LT, Li TC, Sung PK. Subclinical hypothyroidism is associated with increased risk for all cause and cardiovascular mortality in adults. J Am Coll Cardiol. 2012;60(8):730-7. doi: 10.1016/j.jacc.2012.03.047, PMID 22726629.
7. Garber JR, Cobin RH, Gharib H, Hennessey JV, Klein I, Mechanick JI. Clinical practice guidelines for hypothyroidism in adults: cosponsored by the American association of clinical endocrinologists and the American thyroid association. Thyroid. 2012;22(12):1200-35. doi: 10.1089/thy.2012.0205, PMID 22954017.
8. Adachi JD. Corticosteroid induced osteoporosis. Am J Med Sci. 1997;313(1):41-9. doi: 10.1097/00000441-199701000-00007, PMID 9001165.
9. Kaminsky NI, Gimlette T. Creatine kinase in hypothyroid myopathy. Br Med J. 1977;1(6066):1015.
10. Arlot S, Debussche X, Lalau JD. Effects of thyroid dysfunction on renal function. J Endocrinol Invest. 1991;14(8):607-9.
11. Chaudhary N, Singh S, Garg MK. Serum creatine kinase and lactate dehydrogenase in patients with hypothyroidism and hyperthyroidism. Indian J Endocrinol Metab. 2013;17(6):1023-4.
12. Khaleeli AA, Edwards RH, Gohil K, Round JM. Muscle dysfunction in hypothyroidism. Clin Endocrinol (Oxf). 1983;19(6):686-96.
13. Mukhopadhyay P, Das AK, Roy D. Biochemical and clinical profile in hypothyroid patients. Indian J Clin Biochem. 2005;20(2):165-8.
14. Khandelwal D, Tandon N. Overt and subclinical hypothyroidism: who to treat and how. Drugs. 2012;72(1):17-33. doi: 10.2165/11598070-000000000-00000, PMID 22191793.
15. Rodondi N, Den Elzen WP, Bauer DC, Cappola AR, Razvi S, Walsh JP. Subclinical hypothyroidism and the risk of coronary heart disease and mortality. JAMA. 2010;304(12):1365-74. doi: 10.1001/jama.2010.1361, PMID 20858880.
16. Costa Guda J, Lauter K, Naveh Many T, Silver J, Arnold A. Mutational analysis of the PTH 3′-untranslated region in parathyroid disorders. Clin Endocrinol (Oxf). 2006;65(6):806-9. doi: 10.1111/j.1365-2265.2006.02670.x, PMID 17121534.

17. Kaptein EM. Thyroid hormone metabolism and thyroid diseases in chronic renal failure. Endocr Rev. 1996;17(1):45-63. doi: 10.1210/edrv-17-1-45, PMID 8641223.
18. Biondi B, Cooper DS. The clinical significance of subclinical thyroid dysfunction. Endocr Rev. 2008;29(1):76-131. doi: 10.1210/er.2006-0043, PMID 17991805.
19. Lo JC, Chertow GM, Go AS, Hsu CY. Increased prevalence of subclinical and clinical hypothyroidism in persons with chronic kidney disease. Kidney Int. 2005;67(3):1047-52. doi: 10.1111/j.1523-1755.2005.00169.x, PMID 15698444.
20. Marwah S, Marwah N, Saikia UK. Assessment of renal function in hypothyroid patients. Int J Med Sci Public Health. 2013;2(3):589-92.
21. Hegedus L. Clinical practice the thyroid nodule. N Engl J Med. 2004;351(17):1764-71. doi: 10.1056/NEJMcp031436, PMID 15496625.