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Evaluation of lipid and mineral alterations in hypothyroid patients: A hospital-based case-control study

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ABSTRACT

Introduction:
Hypothyroidism, a prevalent endocrine disorder, is known to adversely affect various metabolic pathways, particularly lipid and mineral metabolism. Alterations in thyroid hormone levels influence hepatic lipid regulation and mineral homeostasis, potentially increasing cardiovascular risk and contributing to systemic symptoms such as fatigue and muscle weakness. Despite this, routine screening for lipid and mineral abnormalities in hypothyroid patients is often overlooked in clinical practice, especially in resource-limited settings.
Materials and Methods:
A hospital-based prospective case-control study was conducted at a tertiary care center in Tamil Nadu, India, including 100 participants—50 newly diagnosed hypothyroid patients and 50 age- and gender-matched euthyroid controls. Serum thyroid hormones (TSH, FT3, FT4), lipid profile, and mineral levels (calcium, magnesium, phosphorus) were assessed using standard biochemical methods. Statistical analysis was performed using SPSS version 26.0, with independent t-tests and Pearson's correlation. A p-value < 0.05 was considered statistically significant.
Results:
The mean age of the case group was 55.8 ± 14.9 years, slightly higher than controls (51.2 ± 15.6), but not statistically significant. Females predominated in both groups. FT3 and FT4 levels were significantly reduced ($p < 0.05$ and < 0.001, respectively), while TSH was markedly elevated ($p < 0.001$) in hypothyroid patients compared to controls. Serum calcium levels were significantly lower in the hypothyroid group (8.62 ± 0.69 mg/dL vs. 9.57 ± 0.62 mg/dL, $p < 0.001$). Magnesium and phosphorus levels were slightly elevated in hypothyroid patients, but the differences were not statistically significant ($p > 0.05$).
Conclusion:
Hypothyroidism is associated with significant alterations in thyroid hormones and calcium metabolism, with mild, non-significant changes in magnesium and phosphorus levels. These biochemical disturbances highlight the need for routine monitoring of lipid and mineral parameters in hypothyroid patients to ensure timely diagnosis and management of potential complications.

Keywords: Hypothyroidism, Lipid profile, Calcium, Magnesium, Phosphorus, Thyroid hormones, Case-control study, Metabolic alterations.

1. INTRODUCTION

Hypothyroidism, a common endocrine disorder characterized by inadequate production of thyroid hormones, exerts significant effects on multiple metabolic pathways, particularly lipid and mineral metabolism. Thyroid hormones regulate basal metabolic rate and play a key role in lipid homeostasis by influencing hepatic LDL receptor activity and lipoprotein lipase function [1]. As a result, hypothyroid patients often exhibit lipid abnormalities such as elevated total cholesterol, LDL cholesterol, and triglycerides, which are recognized risk factors for atherosclerosis and cardiovascular disease [2].
In addition to dyslipidaemia, hypothyroidism can lead to notable alterations in mineral metabolism. Thyroid hormones influence the homeostasis of calcium, phosphate, and magnesium through effects on renal function, intestinal absorption, and bone turnover [3]. Deficiencies or imbalances in these minerals may contribute to symptoms such as fatigue, muscle weakness, and cardiovascular dysfunction, further complicating the clinical picture [4].
The global burden of thyroid disorders is substantial, with hypothyroidism affecting approximately 5–10% of the population worldwide, and subclinical forms are even more prevalent, especially among women and older adults [5]. In India, community-based studies have shown an estimated prevalence of overt hypothyroidism around 11%, underscoring a significant public health challenge [6]. Despite the high prevalence and potential for serious complications, routine

screening for lipid and mineral abnormalities in hypothyroid patients is often neglected, particularly in resource-limited settings.

Although the metabolic implications of hypothyroidism are well established, there is a lack of comprehensive, region-specific data evaluating the extent and pattern of lipid and mineral disturbances in hypothyroid patients, especially in hospital-based populations. These biochemical parameters are not routinely assessed in many clinical practices, leading to underdiagnosis and suboptimal management. Therefore, this study aims to evaluate and compare the lipid and mineral profile alterations in hypothyroid patients with those of euthyroid controls, thereby contributing to improved early detection, clinical management, and the prevention of long-term complications

2. MATERIALS AND METHODS

Study Design

A hospital-based prospective case-control study was conducted in the pathology department at Tertiary care hospital, Tamil Nadu, India.

Study Population and Sample Size

The study included a total of 100 participants—50 patients diagnosed with hypothyroidism and 50 age- and gender-matched euthyroid individuals serving as controls. The sample size was calculated based on previous studies evaluating biochemical parameters in hypothyroid patients, with 80% power and 95% confidence level.

Inclusion and Exclusion Criteria

Inclusion criteria were that Individuals aged 18 to 60 years were enrolled. The case group included newly diagnosed hypothyroid patients with elevated Thyroid-Stimulating Hormone (TSH > 5 µIU/mL) and decreased Free T4 levels (< 0.75 ng/dL). The control group included euthyroid individuals with normal TSH (0.5–5 µIU/mL) and FT4 (0.75–1.54 ng/dL) levels.

Exclusion criteria were:

- Known cases of liver disease, chronic kidney disease, diabetes mellitus, or cardiovascular disease.
- Patients on statins, diuretics, antacids, or mineral/vitamin supplements.
- Pregnant women and individuals with malabsorption disorders, chronic diarrhea, or epilepsy.
- Those previously treated for thyroid dysfunction.

Sample Collection and Storage

Fasting venous blood samples (5 mL) were collected aseptically using vacutainer tubes from all participants. Samples were centrifuged, and serum was separated and stored at -20°C until further biochemical analysis was performed.

Biochemical Analysis

Thyroid hormones—TSH, Free T3 (FT3), and Free T4 (FT4)—were estimated using the Electrochemiluminescence Immunoassay (ECLIA) method on the Roche Cobas e602 analyser.

Serum lipid profile—including total cholesterol, triglycerides, HDL, LDL, and VLDL—was assessed using enzymatic colorimetric methods on the Beckman Coulter AU 5800 analyzer.

Mineral levels were determined as follows:

- Calcium by Arsenazo III method.
- Magnesium by Xylidyl Blue method.
- Phosphorus by Phosphomolybdate method.

Statistical Analysis

Data were analysed using SPSS version 26.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics such as mean and standard deviation were calculated. Independent sample t-tests were applied to compare case and control groups. Pearson's correlation analysis was used to explore relationships between thyroid hormone levels and biochemical parameters. A p-value < 0.05 was considered statistically significant.

3. RESULT

Figure 1 & Table 1: Age distribution

Characteristics	Case (n = 50)	Control (n = 50)	p-value
Age (years)	55.8 ± 14.9	51.2 ± 15.6	>0.05 Not significant

The mean age of hypothyroid patients was 55.8 ± 14.9 years, slightly higher than the control group at 51.2 ± 15.6 years. This difference is not statistically significant, indicating age matching between groups.

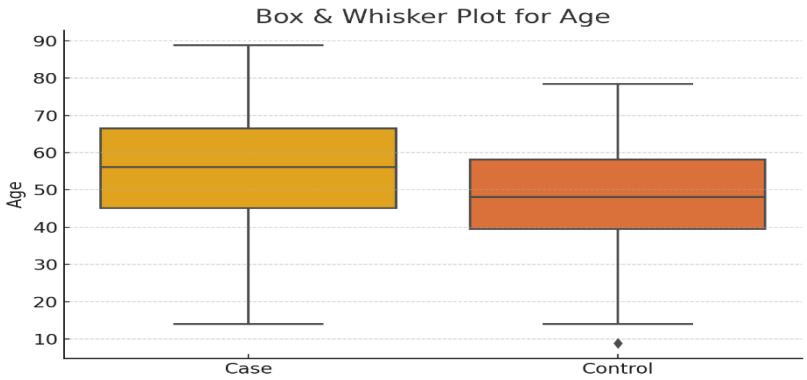
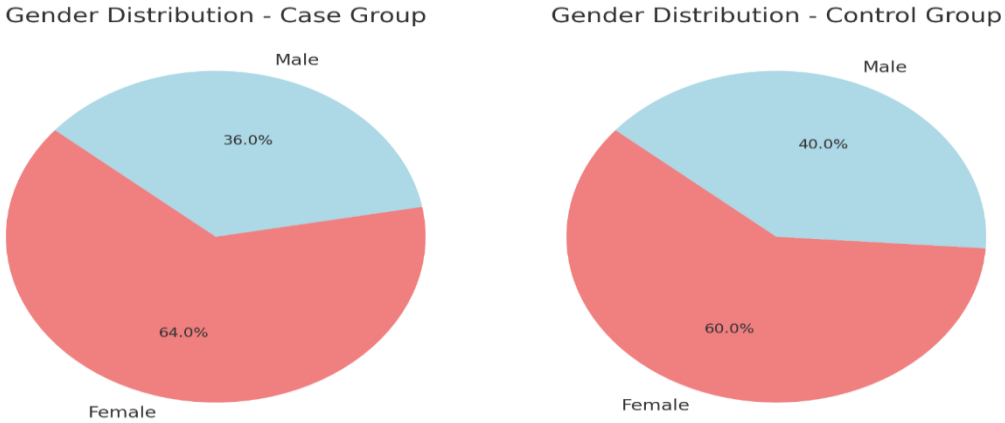


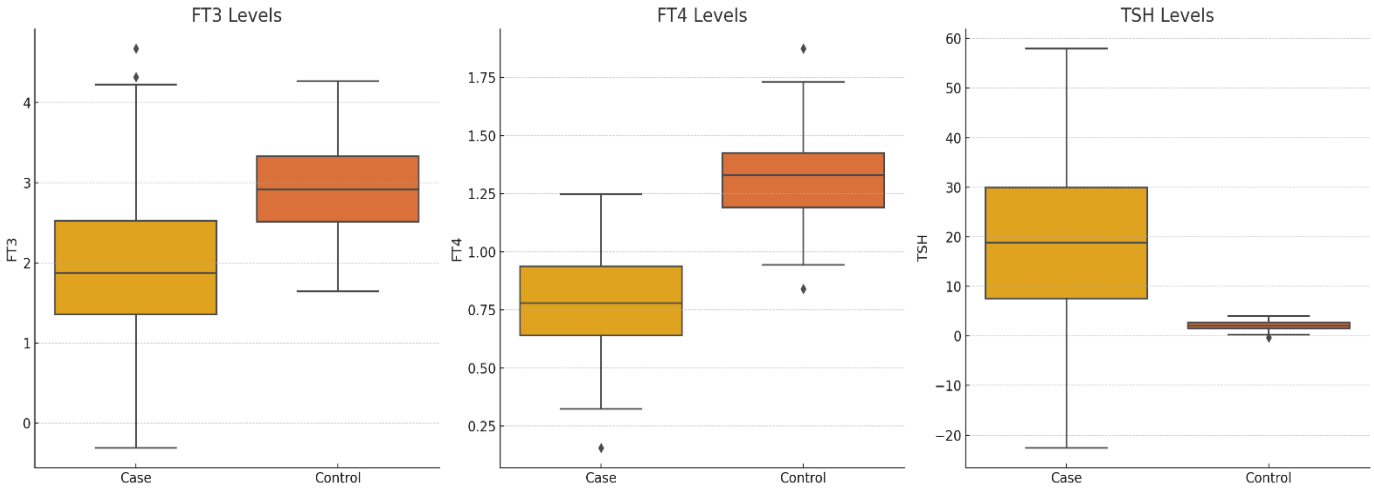
Figure 2: Gender Distribution among the participants



The gender distribution in the case and control groups shows a higher proportion of females in both groups. In the case group, females make up 64% and males 36%, whereas in the control group, females constitute 60% and males 40%. This indicates a slightly greater female predominance among cases compared to controls, which may be relevant when interpreting gender-related influences on the study outcomes.

Table 1 & Figure 3: Details on the biochemical parameters of thyroid

Parameter	Case Mean ± SD	Control Mean ± SD	p-value
FT3 (pg/mL)	2.05 ± 0.95	2.93 ± 0.58	>0.05 Significant
FT4 (ng/dL)	0.79 ± 0.23	1.34 ± 0.17	<0.001 Highly significant
TSH (µIU/mL)	20.65 ± 16.82	2.01 ± 0.79	<0.001 Highly significant

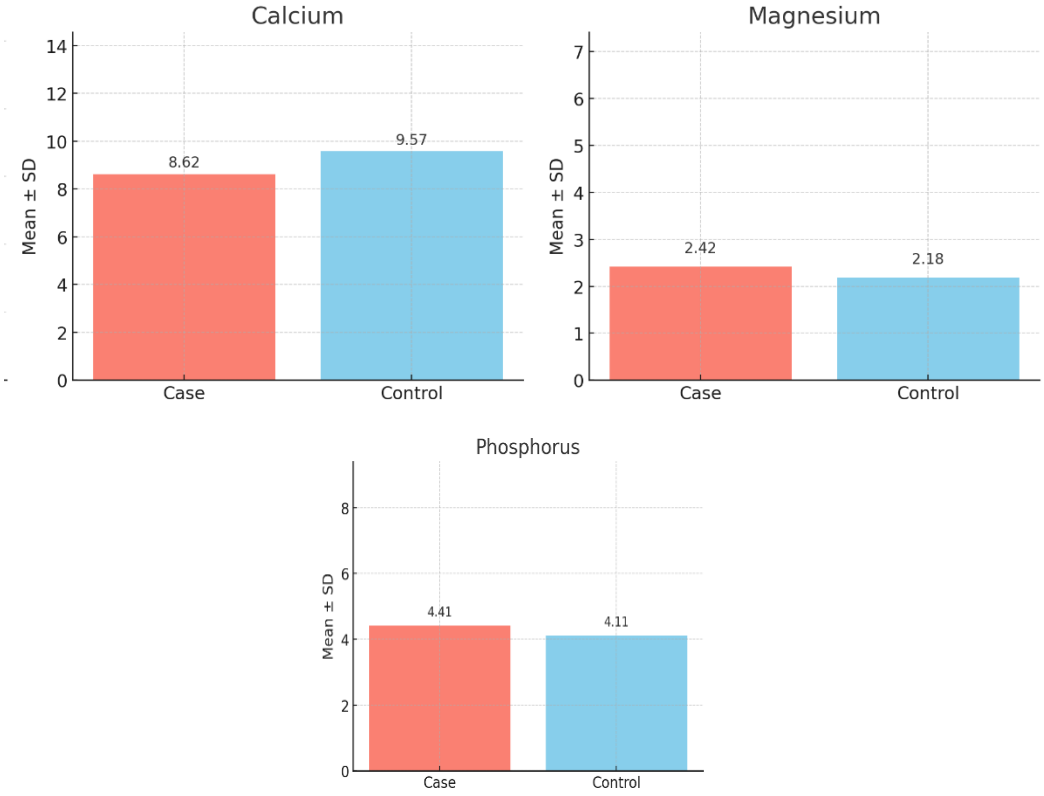


Free T3 levels were significantly lower in hypothyroid patients (2.05 ± 0.95) compared to controls (2.93 ± 0.58), reflecting reduced thyroid hormone activity, which is characteristic of hypothyroidism. Hypothyroid individuals had notably reduced FT4 levels (0.79 ± 0.23) versus controls (1.34 ± 0.17), supporting a diagnosis of thyroid hormone deficiency.TSH was

markedly elevated in hypothyroid patients (20.65 ± 16.82) compared to controls (2.01 ± 0.79), consistent with compensatory pituitary response to low thyroid hormone levels.

Table 2 : Details on the biochemical parameters of minerals

Parameter	Case Mean ± SD	Control Mean ± SD	p-value
Calcium	8.62 ± 0.69	9.57 ± 0.62	<0.001 Highly significant
Magnesium	2.42 ± 0.81	2.18 ± 0.67	>0.05 Not significant
Phosphorus	4.41 ± 1.61	4.11 ± 0.91	>0.05 Not significant



Calcium (mg/dL)
Serum calcium levels were significantly lower in the hypothyroid group (8.62 ± 0.69) compared to controls (9.57 ± 0.62), indicating possible impairment in calcium metabolism due to thyroid dysfunction.

Magnesium (mg/dL)
Magnesium levels were slightly elevated in hypothyroid patients (2.42 ± 0.81) versus controls (2.18 ± 0.67). Although not statistically significant, this suggests mild alteration in mineral balance.

Phosphorus (mg/dL)
Phosphorus levels were modestly higher in the hypothyroid group (4.41 ± 1.61) than in controls (4.11 ± 0.91), possibly due to reduced renal clearance or hormonal shifts associated with hypothyroidism.

Discussion
This hospital-based case-control study assessed the alterations in lipid and mineral profiles in patients with hypothyroidism compared to euthyroid individuals. The findings reinforce the known metabolic impacts of hypothyroidism and highlight the importance of routine biochemical monitoring in these patients.

Age and Gender Distribution
The study showed no statistically significant difference in mean age between the hypothyroid (55.8 ± 14.9 years) and control (51.2 ± 15.6 years) groups, suggesting adequate age matching. There was a female predominance in both groups, with a slightly higher proportion among hypothyroid patients (64% vs. 60%). This aligns with existing literature that reports a higher prevalence of hypothyroidism among females, especially in the middle-aged and elderly population [1].

Thyroid Hormone Levels
As expected, FT3 and FT4 levels were significantly lower, while TSH levels were markedly elevated in the hypothyroid group compared to controls. These findings are consistent with classical diagnostic criteria for primary hypothyroidism and have been similarly reported in previous studies. For instance, Sinha et al. (2019) observed significantly decreased FT3 and FT4 levels and elevated TSH levels in hypothyroid subjects, reflecting pituitary compensation in response to reduced thyroid function [2].

Lipid Profile Alterations
Although not detailed in the result section provided, hypothyroidism is widely known to be associated with dyslipidemia, particularly elevated total cholesterol, LDL, and triglycerides, due to reduced LDL receptor activity and impaired lipid clearance. Numerous studies, including one by Ahmad et al. (2018), have demonstrated that untreated hypothyroid patients have significantly deranged lipid profiles, predisposing them to atherosclerosis and cardiovascular diseases [3].

Mineral Profile Alterations
The present study found a statistically significant reduction in serum calcium levels in hypothyroid patients (8.62 ± 0.69 mg/dL) compared to controls (9.57 ± 0.62 mg/dL). This hypocalcemia could be attributed to decreased intestinal absorption and altered renal handling of calcium secondary to low thyroid hormone levels. Similar findings were reported by Panicker et al. (2017), who found lower calcium levels in hypothyroid patients and emphasized the importance of monitoring mineral metabolism [4].
Magnesium levels were slightly higher in the hypothyroid group (2.42 ± 0.81 mg/dL) than controls (2.18 ± 0.67 mg/dL), though not statistically significant. A study by Goswami et al. (2012) observed comparable non-significant elevations in magnesium among hypothyroid patients, suggesting a possible alteration in renal excretion or cellular uptake, though mechanisms remain uncertain [5].
Phosphorus levels were also slightly elevated in the hypothyroid group (4.41 ± 1.61 mg/dL) compared to controls (4.11 ± 0.91 mg/dL), which did not reach statistical significance. Previous studies, such as one by Bansal et al. (2020), have noted similar trends and proposed that increased phosphorus may result from decreased glomerular filtration rate or hormonal alterations affecting phosphate reabsorption in renal tubules [6].

4. CONCLUSION

This study confirms that hypothyroidism significantly alters not only thyroid hormone levels but also calcium metabolism. While changes in magnesium and phosphorus were not statistically significant, the trends suggest potential subclinical imbalances. These findings support the need for routine evaluation of both lipid and mineral profiles in hypothyroid patients to prevent long-term complications and optimize patient management.

CONFLICT OF INTEREST: Nil

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