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Original Research Article

Lipid Profile Alterations and Their Correlation with Thyroid function test levels in Hypothyroid Patients: A Cross-Sectional Study

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Abstract: ***Background:*** Most common endocrine diseases in the world is thyroid disease This study was aimed at comparing the thyroid functioning and lipid profile features between control and experimental groups in order to measure the biochemical and metabolic alterations associated with hypothyroidism. ***Methods***: This study was conducted at JSS Medical College, patients recruited were 300 people which includes 150 healthy controls and 150 people with hypothyroidism. Statistical tests, descriptive and inferential ones were used to evaluate the variation in blood thyroid hormones (TSH, T3, T4) and lipid parameters (total cholesterol, LDL, HDL, triglycerides, and VLDL). ***Results:*** Thyroid and lipids in the control group were normal with mean TSH of 2.39 ± 0.71 mIU/L, T4 of 1.29 ± 0.22 ng/dL, and T3 of 8.69 ± 1.43 pg/mL, which all are within normal range. The experimental group had much higher levels of TSH (15.27 ± 16.48 mIU/L), lower levels of T4 (1.03 ± 0.26 ng/dL) and T3 (7.51 ± 2.37 pg/mL), which indicate hypothyroidism. The experiment group had elevated total cholesterol (196.06 ± 35.93 mg/dl), LDL (143.64 ± 33.50 mg/dl), triglycerides (177.85 ± 58.58 mg/dl) and VLDL (36.30 ± 11.07 mg/dl), whereas the HDL was lower than in the control group (50.79 ± 11.82 mg/dl). The results provide statistically significant correlation between thyroid malfunction and dyslipidemia, ***Conclusion***: It is advisable that people with hypothyroidism should be monitored with lipid levels at regular intervals so that any metabolic imbalances that are about to develop can be averted early, In continuation of this research, future work will focus on correlating these biochemical profiles with receptor function at the cellular level..

Keywords: Thyroid dysfunction, Hypothyroidism, Lipid profile, Dyslipidemia,

INTRODUCTION

One of the most common endocrine diseases in the world is thyroid disease, and it strikes approximately 42 million people in India alone1. Thyroid gland is highly significant as it secretes hormones called tetraiodothyronine (T4) and triiodothyronine (T3), which control energy and enable a person to have an active lifestyle. The hormones play a central role in keeping the cell membranes intact by controlling the amount of phospholipids and fatty acid composition of lipids2. Thyroid hormones regulate the body's use of fats; when the thyroid functions improperly, it may lead to abnormalities in blood fat levels, increasing the risk of cardiovascular disease, hypertension, and vascular complications3. In hyperthyroidism, the body metabolizes proteins, carbohydrates, and lipids at an accelerated rate4. Hypothyroidism, a prevalent thyroid disorder worldwide, occurs when the thyroid fails to generate sufficient hormones5. This disease results from insufficient amounts of T4 and T3 in the body6. Hypothyroidism is a continuum of disease that consists of abnormal test results of thyroid function tests, which can or cannot be symptomatic. Disease of the thyroid is generally caused by the overproduction or underproduction of the thyroid

gland's hormones. Hypothyroidism is caused by insufficient hormone production, whereas hyperthyroidism is caused by hyperactivity of the gland with elevated circulating levels of free thyroid hormones like T4, T3, or both7.Symptoms of hyperthyroidism include dyspnea, tachycardia, anxiety, tremors, heat intolerance, weight loss despite normal or heightened hunger, and increased stool frequency8,9. Symptoms of hypothyroidism include fatigue, weight gain, depression, joint and muscular discomfort, difficulty tolerating cold, dry skin, hair loss, irregular or heavy menstrual cycles, reproductive problems, and bradycardia10. In hyperthyroidism, blood analysis reveals decreased TSH levels and elevated concentrations of free T4 and T3. Thyroid disorders often alter lipid levels in the bloodstream. In hypothyroidism, levels of LDL-C (low-density lipoprotein cholesterol) and HDL-C (high-density lipoprotein cholesterol) rise, but in hyperthyroidism, they decrease11. These changes are effects of thyroid hormones on lipoprotein and lipid metabolism12. Studies have contrasted the effects of thyroid diseases, including hypothyroidism and hyperthyroidism, on lipid blood levels,

Hypothyroidism is a disorder resulting from insufficient thyroid hormones, causing a general deceleration of the body's metabolic functions13. This is a prevalent metabolic disorder among the general population14. The condition's prevalence increases with age, especially in women15. Hypothyroidism is associated with many metabolic alterations. As thyroid function diminishes, total cholesterol and low-density lipoprotein (LDL) cholesterol levels often increase. Hypothyroidism is a significant contributor to secondary dyslipidemia, a disorder characterized by elevated cholesterol levels16. In individuals with hypothyroidism, despite a decrease in the activity of HMG CoA reductase (an enzyme involved in cholesterol synthesis), total blood cholesterol levels often rise, mostly attributed to elevated levels of LDL cholesterol and intermediate-density lipoprotein (IDL) cholesterol. Reduced thyroid hormone levels result in elevated blood cholesterol concentrations, since less cholesterol is excreted via bile and feces, attributable to a decreased number of LDL receptors on hepatic cells16-19. The primary cause of elevated cholesterol in hypothyroidism is the diminished function of LDL receptors, which impedes the degradation of LDL and IDL20. Research indicates inconsistent findings on high-density lipoprotein (HDL) cholesterol levels in hypothyroidism. Patients newly diagnosed with hypothyroidism often have elevated HDL cholesterol levels, exceeding 40 mg/dL, in both moderate and severe instances; whereas, those on thyroid replacement treatment or possessing normal thyroid function generally show reduced HDL cholesterol levels20.

Patients with hypothyroidism often have elevated HDL cholesterol levels, mostly attributable to an increase in HDL2 particles21. But some studies have conflicting findings; for example, HDL cholesterol was lowered by 25.9% in thyroidectomized rats, indicating disturbed HDL metabolism22. Additional research has shown reduced HDL cholesterol levels in some hypothyroid individuals21. Moreover, decreased thyroid hormone levels markedly elevate blood triglyceride concentrations18. Nikkilia and Kekki assert that elevated triglyceride levels in hypothyroidism arise from diminished lipoprotein lipase (LPL) activity, which impedes the clearance of triglyceride-rich lipoproteins23. Hypothyroid geriatric adults exhibited dyslipidemia, characterized by elevated triglycerides, total cholesterol, LDL-C, and VLDL-C, with significant positive correlation between TSH and VLDL-C24. Patients with hypothyroidism, especially overt hypothyroidism, had raised LDL, triglycerides, and cholesterol when compared with euthyroid patients, with lipid levels showing poor correlations with TSH/FT4, but HDL did not exhibit significant correlation25. The total cholesterol, triglycerides, VLDL, LDL, and LDL/HDL ratio of hypothyroid patients were higher than the euthyroid subjects whereas, the levels of HDL, total cholesterol, triglycerides, VLDL, LDL, and LDL/HDL ratio were lower than the euthyroid subjects26. Patients with hyperthyroidism revealed reduced levels of triglycerides, total cholesterol, and LDL cholesterol, whereas those with hypothyroidism had elevated levels of triglycerides, LDL cholesterol, total cholesterol, and HDL cholesterol in comparison to controls27. Patients with hypothyroidism, especially females, had moderate dyslipidemia characterized by high LDL and triglycerides, reduced HDL, and low-grade inflammation as seen by increased hs-CRP levels, with subclinical hypothyroidism occurring more often than clinical hypothyroidism28. Thyroid dysfunction, especially hypothyroidism, correlated with increased total cholesterol, LDL, and triglycerides, with a greater incidence seen in female subjects29. Individuals with metabolic syndrome had elevated triglycerides and TSH levels, and reduced HDL, in comparison to controls, suggesting a notable correlation between thyroid dysfunction and modified lipid profiles30.

Aim: To study the Lipid profile and TFT profile in hypothyroidism patients.

Objective 1: To assess the profile of Hypothyroidism patients attending tertiary care hospitals in Mysuru.

Objective 2:

- To compare the lipid profiles (e.g., total cholesterol, LDL, HDL,VLDL and triglycerides(TG) in patients with hypothyroidism.
- To determine if there is a correlation between the levels of thyroid-stimulating hormone (TSH) and specific lipid parameters in patients

diagnosed with hypothyroidism.

MATERIAL AND METHODS:

Study Design: This cross-sectional analytical investigation was performed in Biochemistry laboratory of JSS Hospital, Mysuru. after clearance from the institutional ethical committee (JSSMC/IEC/17112021/41 NCT/2021-22) and obtaining informed consent from participants.

Duration of the study: The study was conducted over two years

Inclusion criteria:

- Patient who are willing to give consent for our study
- Reproductive age group, Male and Female
- Who are under supplements (Thyroxine)

Exclusion criteria:

- Diabetes mellitus, Hypertension, Neoplasm, Pregnancy,
- Alcohol abuse and Smoking and those who are not willing to give consent.

RESULTS

Following an overnight fast of 8–12 hours, Venous blood was collected; serum was isolated by centrifugation and analyzed on the same day. Serum total cholesterol, triglycerides, HDL, VLDL and LDL were quantified via standard enzymatic techniques on an automated bio-chemistry analyzer, while serum T3, T4 and TSH was assessed using a validated immunoassay (e.g., chemi-luminescent immunoassay) in accordance with manufacturer protocols. Demographic and clinical information was documented. Statistical tests were used for testing the significance in the levels (p-values) of lipids and TFT in hypothyroidism patients and associations were analyzed between demographic factors, lipid levels and TFT levels in the different groups being tested.

RESULTS:

Table 1: Shows the sex (gender) and age of male and female patients in the two groups:

Characteristic	Control (N=150)	Experimental (hypothyroidism) (N=150)
Sex		
Male	74 (49.3%)	49 (32.7%)
Female	76 (50.7%)	101 (67.3%)
Age (mean ± SD, years)	37.81 ± 9.00	42.37 ± 10.95

Table 1: Shows the male and female gender number and percentage with age mean and standard deviation in the two groups.

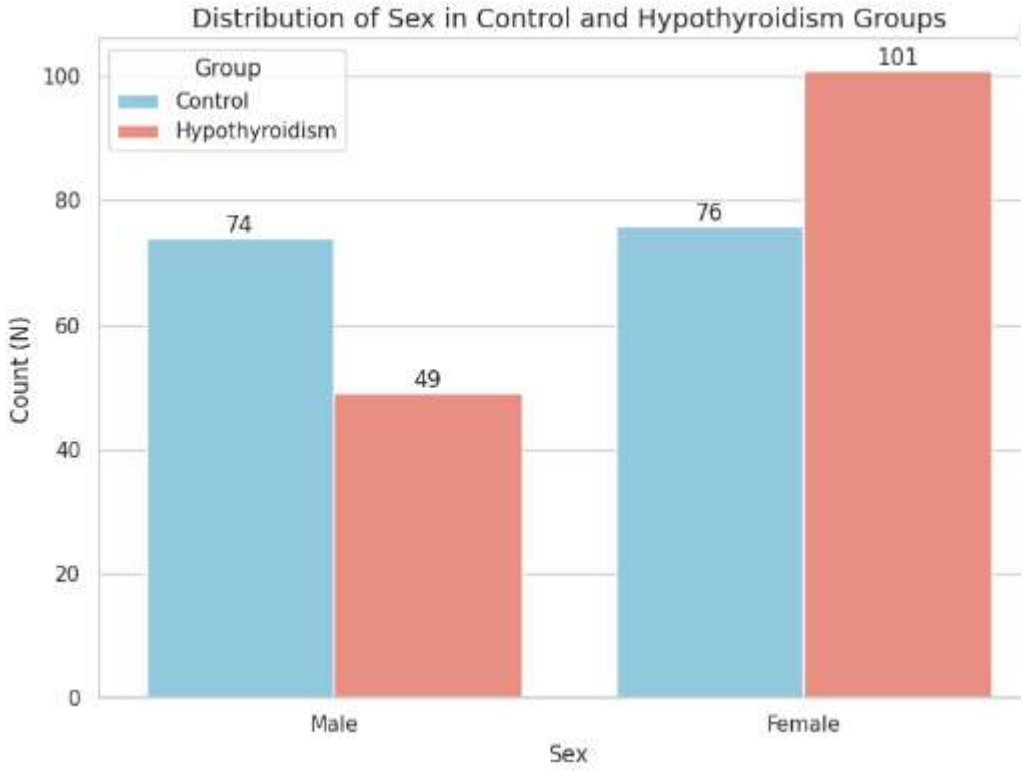

Fig 1 shows the gender (sex) and age of the male and female in the two groups being studied

Table 2: Descriptive statistics of Lipid Profile and Thyroid functional levels between control and experimental group of patients.

Group	Parameter	Mean	SD	Variance	Range	Min	Max	Skewness	Kurtosis
Control	Age	37.81	9.00	80.95	30.00	25.00	55.00	0.26	-1.16
	TSH	2.39	0.71	0.50	3.77	0.43	4.20	-0.23	-0.03
	T4_ng_dL	1.29	0.22	0.05	1.27	0.58	1.85	0.15	0.10
	T3_pg_mL	8.69	1.43	2.06	7.06	4.87	11.93	-0.03	-0.43
	Total Cholesterol	175.37	20.28	411.35	79.10	125.00	204.10	-0.49	-0.83
	LDL	108.26	19.62	385.10	125.70	54.60	180.30	0.14	0.81
	HDL	53.43	8.74	76.47	41.60	32.30	73.90	-0.07	-0.63
	Triglycerides	126.47	29.83	889.74	157.20	49.20	206.40	-0.08	-0.07
	VLDL	23.73	4.13	17.08	21.40	12.50	33.90	-0.01	-0.04
Experimental	Age	42.37	10.95	119.87	43.00	15.00	58.00	-0.54	-0.79
	TSH	15.27	16.48	271.61	94.29	0.71	95.00	2.79	8.10
	T4_ng_dL	1.03	0.26	0.07	2.06	0.19	2.25	0.39	3.55
	T3_pg_mL	7.51	2.37	5.64	14.40	0.50	14.90	-0.16	0.53
	Total Cholesterol	196.06	35.93	1291.06	187.00	104.00	291.00	0.18	0.04
	LDL	143.64	33.50	1122.31	176.00	56.00	232.00	0.07	-0.44
	HDL	50.79	11.82	139.63	83.00	27.00	110.00	1.14	3.39
	Triglycerides	177.85	58.58	3432.07	410.00	69.00	479.00	1.22	3.93
	VLDL	36.30	11.07	122.45	80.00	14.00	94.00	1.27	4.36

Table 2: indicates that the control group had normal thyroid and lipid levels, with mean TSH, T3, and T4 values within physiological limits and lipid parameters that were balanced. The experimental group had increased TSH and reduced T3 and T4, indicating hypothyroid dysfunction. The lipid profile indicated significantly elevated levels of total cholesterol, LDL, triglycerides, and VLDL, but HDL exhibited a small decrease. The elevated skewness and kurtosis results in the experimental group indicate variability and metabolic disruption linked to thyroid imbalance.

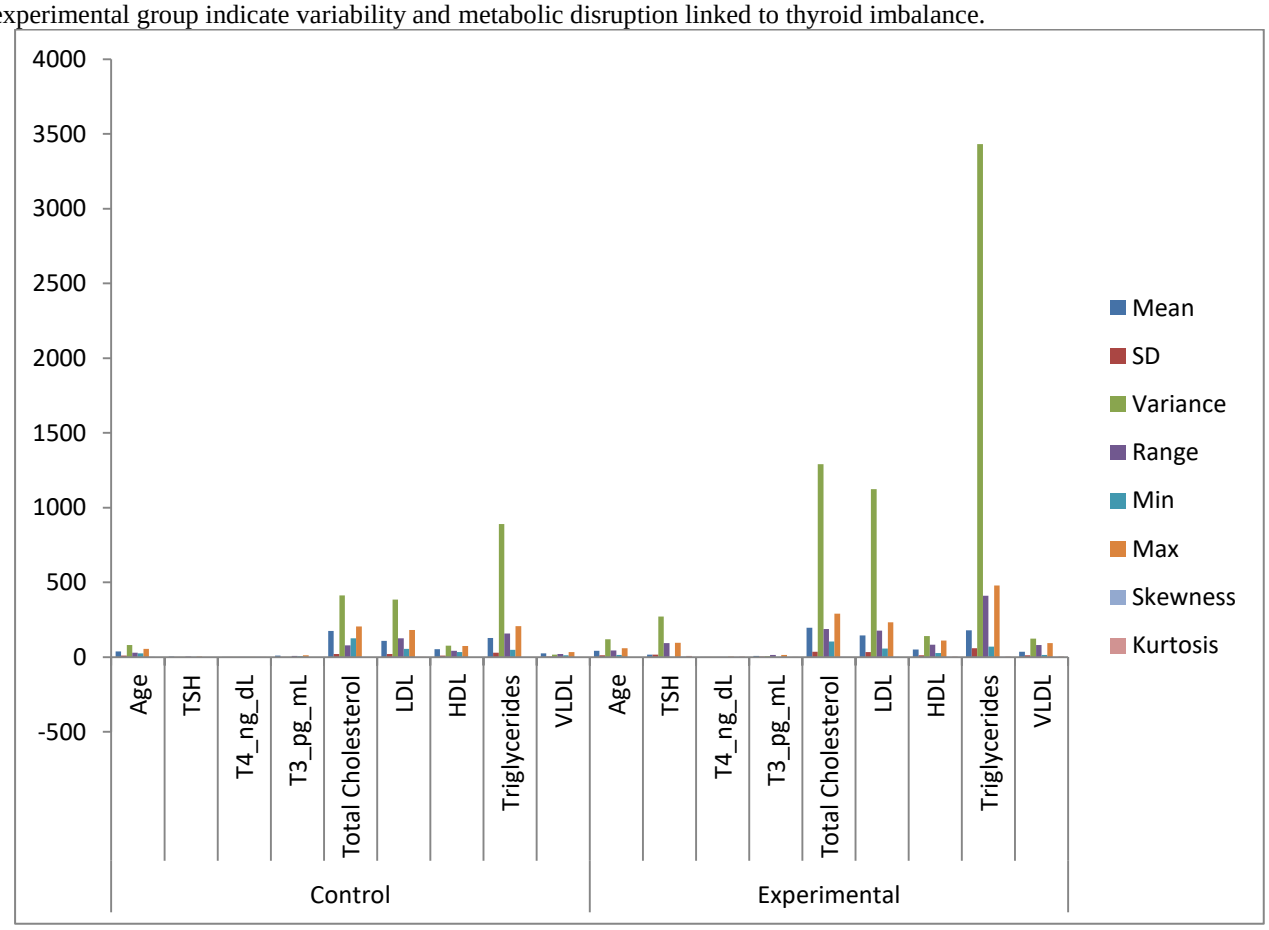

Fig. 2 shows the control and experimental group different variables measurements with statistical analysis

Table 3: Difference in means of Lipid Profile and Thyroid function Levels between control (N=150) and experimental group of patients (N=150):

Variables	Group	N	Mean	SD	t value	p value
Age_yrs	Control	150	37.8	9.0	-3.947	0.000**
	Experimental	150	42.4	10.9		
TSH_mIU_L	Control	150	2.4	0.7	-9.565	0.000**
	Experimental	150	15.3	16.5		
Free T4_ng_dL	Control	150	1.3	0.2	0.9052	0.000**
	Experimental	150	1.0	0.3		
Free T3_pg_mL	Control	150	8.7	1.4	5.195	0.000**
	Experimental	150	7.5	2.4		
Total Chol_mg_dL	Control	150	175.4	20.3	-6.141	0.000**
	Experimental	150	196.1	35.9		
LDL_mg_dL	Control	150	108.3	19.6	-11.159	0.000**
	Experimental	150	143.6	33.5		
HDL_mg_dL	Control	150	53.4	8.7	2.189	0.029*
	Experimental	150	50.8	11.8		
Triglycerides_mg_dL	Control	150	126.5	29.8	-9.573	0.000**
	Experimental	150	177.9	58.6		
VLDL_mg_dL	Control	150	23.7	4.1	-12.993	0.000**
	Experimental	150	36.3	11.1		

*p<0.05

Table 3: shows that the thyroid and cholesterol markers significant differences ($p < 0.05$) between experimental and control groups are statistically significant. The experimental group was characterized by the increased concentration of TSH and lower levels of T3 and T4, thus having hypothyroid dysfunction. Lipid profile showed an alarming increase in the total cholesterol, LDL, and triglycerides as well as VLDL with HDL levels decreasing moderately yet significantly. These findings prove that there is a strong association between the imbalance of thyroid hormones and dyslipidemia, implying an increased risk of cardiovascular complications in patients with hypothyroidism.

DISCUSSION

Table 1 shows the sex (gender) and age of the male and female in the two groups being studied. Table 2 indicates that the control group had normal thyroid and lipid parameters, while the experimental group showed higher TSH levels, decreased T3 and T4 levels, and an abnormal lipid profile, indicating hypothyroid-associated dyslipidemia. Table 3 demonstrates statistically significant differences ($p < 0.05$) between the control and experimental groups for all thyroid and lipid variables, hence affirming a robust correlation between hypothyroidism and altered lipid metabolism.

The results of a previous study have shown that T4 and TSH do not vary between non-obese and obese people, which confirm the findings by Manji et al., which concluded that TSH and BMI are not strongly related31. Nonetheless, Francis indicated that TSH levels were elevated in those with increased BMI, which contradicts this32. Kitahara et al., also discovered no correlation between BMI and T4 or TSH levels, suggesting that these thyroid hormones may not significantly influence body weight regulation, nor does body weight substantially impact them33. A more recent study by Ranabir et al. in the community study cited no relationship between TSH and BMI, meaning that keeping TSH in the lower normal range is not likely to help people lose weight, rather the promotion of lifestyle changes, diet, and exercise34. On the other hand, Solanki et al., found out that TSH rose with rise in BMI, perhaps because TSH induces fat cell growth35,36. Pergola et al., found that there exists a correlation between thyroid hormones and body weight37. Thyroid hormones augment the production and metabolism of energy, which could explain its relation with BMI38.

Rotondi et al. suggested that the effect of body weight on thyroid function is affected by the extent of overweight or obesity39. In the present study, a relatively low mean BMI of 28.19 ± 3.34 kg/m² was observed, which could be the reason for the lack of correlation between BMI and thyroid hormones. The obese individuals showed an inverse correlation between T4 and TSH, suggesting their interdependent role in controlling thyroid function.
Kim et al. showed that TC and TG were elevated in obesity compared with normal weight individuals, that TC and TG rose with BMI, whereas HDL cholesterol fell40. A study in a Korean community

showed there to be positive correlation between BMI and TC and LDL cholesterol41, indicating that lipid disorders are prevalent in obesity. No significant differences in lipid profiles were noted between the obese and non-obese groups in this investigation, possibly due to high intake of green vegetables and fish, decreased consumption of processed foodstuffs, and increased active rural life. The low rate of obesity (3.9% of them being obese only) and ubiquitous prevalence of overweight persons account for the lack of differences in the levels of total cholesterol and triglycerides. This is in concordance with findings of Hussain and others wherein no statistical correlation of lipid profiles with BMI42 was observed. Bayram and others showed lipid abnormalities to occur more often with higher BMI43; but in our study, lipids were normal and similar in both groups and would suggest that BMI cannot directly affect lipid profiles. Additional variables such as lifestyle, nutrition, or genetics within the community may more accurately elucidate lipid abnormalities and need additional investigation. Both adipose tissue and the thyroid gland secrete chemicals (adipocytokines and thyroid hormones) that are essential for metabolism44.

This research identified a negative correlation between T4 and TC, TG, HDL, LDL, and VLDL, aligning with Essam H Jiffri's results that elevated T4 levels correspond to reduced lipid levels and vice versa45. Roos et al., discovered a negative correlation between free T4 and TG and HDL cholesterol, maybe due to the influence of thyroid hormones on hepatic cholesterol synthesis. TSH exhibited no significant correlation with lipid profiles in our study, consistent with research indicating no association between TSH and lipids (TC, TG, HDL, LDL), although the established relationship between diminished thyroid function and elevated TC and LDL levels46-49. Conversely, Amer et al. indicated a positive correlation between TSH and TC, TG, and LDL50, whereas Shekhar et al. discovered an association between TSH and TC and LDL in hypothyroid individuals 51. Garduno-Garcia observed positive correlations between TSH and TC and TG 54, whereas Asvold et al., identified positive correlations between TSH and TC, TG, and LDL, but a negative correlation with HDL52. Notably, several researches indicate that even typical fluctuations in TSH and thyroid hormone levels may influence body weight and lipid profiles53. This research revealed that T4 and lipid levels, albeit within normal ranges, were interrelated, indicating that T4 and lipid profiles independently affect one another, irrespective of BMI53. Nonetheless, Garduno-Garcia discovered a favorable correlation between T4 and HDL, contrasting with the findings of the other investigations54.

CONCLUSION:

The research finds that thyroid malfunction, especially hypothyroidism, significantly affects lipid metabolism, resulting in dyslipidemia. Increased TSH and diminished T3 and T4 levels correlated with elevated total cholesterol, LDL, triglycerides, and VLDL, as well as lower HDL in hypothyroid patients. These metabolic abnormalities increase the likelihood of cardiovascular problems in persons with hypothyroidism. Consistent monitoring of thyroid function and lipid levels is crucial for the early identification and prevention of associated diseases.

In continuation of this research, future work will focus on correlating these biochemical profiles with receptor function at the cellular level. Such integrated molecular and biochemical approaches are expected to provide deeper insights into thyroid hormone signaling and may pave the way for more precise diagnostic and therapeutic strategies.

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