Original Article
DOI: https://doi.org/10.70749/ijbr.v3i2.631

INDUS JOURNAL OF BIOSCIENCE RESEARCH
https://induspublishers.com/IJBR
ISSN: 2960-2793/ 2960-2807

Effect of Thyroid Disorders on Cardiovascular Risk in Type 2 Diabetes Mellitus Patients

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ARTICLE INFO

Keywords

Thyroid Dysfunction, Type 2 Diabetes, Cardiovascular Risk, Hypothyroidism, Hyperthyroidism, Lipid Metabolism, Arterial Stiffness, Glycemic Control, Inflammation, Echocardiography.

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Declaration

Author's Contributions: All authors equally contributed to the study and approved the final manuscript.

Conflict of Interest: No conflict of interest.

Funding: No funding received by the authors.

Article History

Received: 04-01-2024
Revised: 29-01-2025
Accepted: 06-02-2025

ABSTRACT

Introduction: Thyroid disorders and type 2 diabetes mellitus (T2DM) are two interlinked endocrine conditions that frequently coexist. Emerging evidence suggests that thyroid dysfunction may exacerbate cardiovascular risks in T2DM patients by influencing lipid metabolism, insulin sensitivity, and vascular health. **Objective:** To evaluate the impact of thyroid disorders, including hypothyroidism and hyperthyroidism, on cardiovascular risk profiles in patients with type 2 diabetes mellitus. **Methodology:** This study examined the relationship between thyroid function and cardiovascular risk in patients with type 2 diabetes mellitus at Shalamar Hospital, Lahore, during July to December 2024. A total of 175 participants met the inclusion criteria, ensuring reliable thyroid function assessments. Data collection involved thyroid function tests, lipid profiles, blood pressure monitoring, and echocardiographic evaluations. Statistical analysis using SPSS v26 included descriptive statistics, t-tests, and chi-square tests, with significance set at $p<0.05$. The study's findings contribute to understanding the impact of thyroid function on cardiovascular health in diabetic patients, potentially aiding in better disease management and risk stratification strategies. **Results:** Thyroid dysfunction affected 40% of patients, with hypothyroidism (25%) being most common. Patients with thyroid disorders showed higher LDL (135 mg/dL vs. 100 mg/dL), triglycerides (180 mg/dL vs. 140 mg/dL), arterial stiffness (60% vs. 35%), and systemic inflammation (CRP 6.5 mg/L vs. 3.8 mg/L). Glycemic control was poorer, with HbA1c 8.2% vs. 7.5%, highlighting increased cardiovascular risk in this population. **Conclusion:** Thyroid dysfunction is a significant modifiable risk factor for cardiovascular complications in T2DM patients. Early detection and management of thyroid disorders could mitigate cardiovascular risks and improve overall outcomes.

INTRODUCTION

Thyroid disorders and type 2 diabetes mellitus (T2DM) represent two of the most prevalent endocrine conditions worldwide, each posing significant health burdens on individuals and healthcare systems [1]. While these disorders are distinct in their pathophysiology, there is substantial evidence to suggest a strong bidirectional relationship between thyroid function and glucose metabolism [2]. Thyroid hormones play a pivotal role in regulating metabolic processes, including glucose homeostasis, lipid metabolism, and energy expenditure. Conversely, the presence of T2DM can alter thyroid hormone levels and function, creating a complex interplay between these conditions. This interaction is particularly significant in the context of cardiovascular health, as both thyroid dysfunction and T2DM independently increase the risk of cardiovascular disease (CVD) [3].

In patients with T2DM, cardiovascular complications such as atherosclerosis, hypertension, and heart failure are leading causes of morbidity and mortality [4]. Thyroid dysfunction, whether hypothyroidism or hyperthyroidism, has been shown to exacerbate these risks by influencing lipid profiles, endothelial function, and vascular stiffness. For instance, hypothyroidism is associated with elevated levels of low-density lipoprotein (LDL) cholesterol and

triglycerides, while hyperthyroidism can lead to tachycardia and arrhythmias, further compounding cardiovascular risks [5]. Subclinical thyroid dysfunction, often underdiagnosed in diabetic populations, may also contribute to the progression of CVD by subtly altering metabolic and vascular parameters. The interplay between thyroid disorders and T2DM in relation to cardiovascular risk is multifaceted. Hypothyroidism, characterized by elevated thyroid-stimulating hormone (TSH) and reduced levels of T3 and T4, is associated with reduced insulin sensitivity, dyslipidemia, and increased arterial stiffness [6]. These factors collectively contribute to the development of atherosclerosis and left ventricular dysfunction. On the other hand, hyperthyroidism, marked by suppressed TSH and elevated T3 and T4, can exacerbate hyperglycemia, increase heart rate, and promote atrial fibrillation, all of which are detrimental to cardiovascular health. Subclinical forms of both hypothyroidism and hyperthyroidism, which often go unnoticed, may also subtly impact cardiovascular outcomes in T2DM patients, underscoring the need for routine thyroid function screening in this population [7].

OBJECTIVE

To evaluate the prevalence of thyroid disorders and their impact on cardiovascular risk factors in patients with type 2 diabetes mellitus.

METHODOLOGY

This cross-sectional study was conducted at Shalamar Hospital, Lahore during July to December 2024. A total of 175 patients with a confirmed diagnosis of type 2 diabetes mellitus were included.

Inclusion Criteria

- Adults aged ≥18 years with a diagnosis of T2DM for at least one year.
- Availability of complete thyroid function test results (TSH, T3, T4).
- No recent history of thyroid surgery or radioactive iodine therapy.

Exclusion Criteria

- Patients with type 1 diabetes mellitus or gestational diabetes.
- Severe comorbidities such as chronic kidney disease or active malignancy.
- Use of medications affecting thyroid function, such as amiodarone or corticosteroids.

Data Collection

Data collection involved a comprehensive evaluation of thyroid function and cardiovascular risk factors in all participants. Thyroid function was assessed using serum levels of TSH, T3, and T4, measured via enzyme-linked immunosorbent assay (ELISA). Cardiovascular risk was evaluated through a combination of clinical assessments and laboratory investigations. Lipid profiles, including total cholesterol, LDL, HDL, and triglycerides, were measured using standard biochemical methods. Blood pressure was recorded using a digital sphygmomanometer, while arterial stiffness was assessed through pulse wave velocity measurements. Echocardiographic evaluations were performed to detect structural and functional abnormalities, such as left ventricular hypertrophy and ejection fraction. Demographic and clinical data, including age, gender, duration of diabetes, and glycemic control (HbA1c), were obtained through patient interviews and medical records.

Statistical Analysis

Data were analyzed using SPSS v26. Descriptive statistics helped summarize important details like age, cholesterol levels, blood sugar, and heart function. To see if there were meaningful differences, we used t-tests for continuous data (like cholesterol levels) and chi-square tests for things like the presence of high blood pressure. Any differences found with a p-value under 0.05 were considered significant.

RESULTS

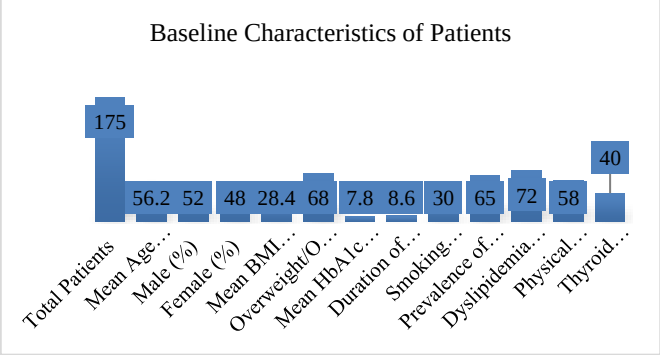
The study included 175 patients with a mean age of 56.2± 11.4 years, balanced gender distribution (52% male, 48% female), and a mean BMI of 28.4 kg/m². Overweight or obesity was present in 68%, while 65% had hypertension and 72% had dyslipidemia. Thyroid dysfunction affected 40% of participants, highlighting its prevalence in this cohort.

Table 1

Baseline Characteristics of Patients

Parameter	Value
Total Patients	175
Mean Age (years)	56.2 ± 11.4
Male (%)	52
Female (%)	48
Mean BMI (kg/m²)	28.4 ± 3.7
Overweight/Obesity (%)	68
Mean HbA1c (%)	7.8 ± 1.5
Duration of T2DM (years)	8.6 ± 4.3
Smoking History (%)	30
Prevalence of Hypertension (%)	65
Dyslipidemia (%)	72
Physical Inactivity (%)	58
Thyroid Dysfunction Prevalence (%)	40

Figure 1



Hypothyroidism (25%) was the most common thyroid disorder, followed by hyperthyroidism (10%) and subclinical hypothyroidism (5%). Hypothyroidism showed high TSH (5.8 µIU/mL) with low free T4 (0.6 ng/dL), while hyperthyroidism had suppressed TSH (0.2 µIU/mL) with elevated free T4 (2.5 ng/dL).

Table 2

Prevalence and Characteristics of Thyroid Disorders

Thyroid Disorder	Prevalence (%)	Mean TSH (µIU/mL)	Mean Free T4 (ng/dL)	Mean Free T3 (pg/mL)
Euthyroid	60	1.2 ± 0.4	1.3 ± 0.2	2.9 ± 0.4
Hypothyroidism	25	5.8 ± 1.2	0.6 ± 0.1	2.0 ± 0.3
Hyperthyroidism	10	0.2 ± 0.1	2.5 ± 0.4	4.1 ± 0.6
Subclinical Hypothyroidism	5	3.5 ± 0.7	1.1 ± 0.1	2.8 ± 0.3

Thyroid dysfunction patients had worse lipid profiles, including higher LDL (135 mg/dL vs. 100 mg/dL) and total cholesterol (220 mg/dL vs. 190 mg/dL), alongside lower HDL (40 mg/dL vs. 50 mg/dL). Elevated triglycerides (180 mg/dL) and lipoprotein(a) (35 mg/dL) further indicated higher cardiovascular risk.

Table 3

Lipid Profiles in Patients with and without Thyroid Dysfunction

Lipid Parameter	Thyroid Dysfunction (Mean ± SD)	No Thyroid Dysfunction (Mean ± SD)	Recommended Levels
Total Cholesterol (mg/dL)	220 ± 30	190 ± 25	<200
LDL Cholesterol (mg/dL)	135 ± 20	100 ± 15	<100
HDL Cholesterol (mg/dL)	40 ± 5	50 ± 6	>50
Triglycerides (mg/dL)	180 ± 25	140 ± 20	<150
Non-HDL Cholesterol (mg/dL)	180 ± 30	140 ± 25	<130
Lipoprotein(a) (mg/dL)	35 ± 8	25 ± 7	<30

Key cardiovascular risks included hypertension (70%), arterial stiffness (60%), and LVH (45%), with high hs-CRP levels (6.5 mg/L) and carotid plaques in 50%. These findings highlight the vascular and inflammatory burden of thyroid dysfunction.

Table 4

Cardiovascular Risk Factors in Patients with Thyroid Dysfunction

Risk Factor	Prevalence (%)	Mean Value	Recommended Level
Hypertension	70	140/90 mmHg	<130/80 mmHg
Arterial Stiffness (Pulse Wave Velocity)	60	10.2 ± 2.4 m/s	<10 m/s
Left Ventricular Hypertrophy (LVH)	45	120 ± 15 g/m²	<115 g/m²
Elevated High-Sensitivity CRP	68	6.5 ± 2.1 mg/L	<3 mg/L
Carotid Intima-Media Thickness (CIMT)	50	1.1 ± 0.3 mm	<0.9 mm

Patients with thyroid dysfunction showed reduced LVEF (55% vs. 60%) and higher left ventricular mass index (120 g/m² vs. 100 g/m²). Diastolic dysfunction (40%) and elevated pulmonary artery pressure (35 mmHg) were more prevalent compared to euthyroid patients.

Table 5

Echocardiographic Findings in Patients with Thyroid Dysfunction

Parameter	Thyroid Dysfunction (Mean ± SD)	No Thyroid Dysfunction (Mean ± SD)	Normal Range
Left Ventricular Ejection Fraction (%)	55 ± 5	60 ± 4	>55
Left Ventricular Mass Index (g/m²)	120 ± 15	100 ± 12	<115
Diastolic Dysfunction (%)	40	20	N/A
Pulmonary Artery Pressure (mmHg)	35 ± 8	25 ± 6	<25
Aortic Valve Sclerosis (%)	30	10	N/A

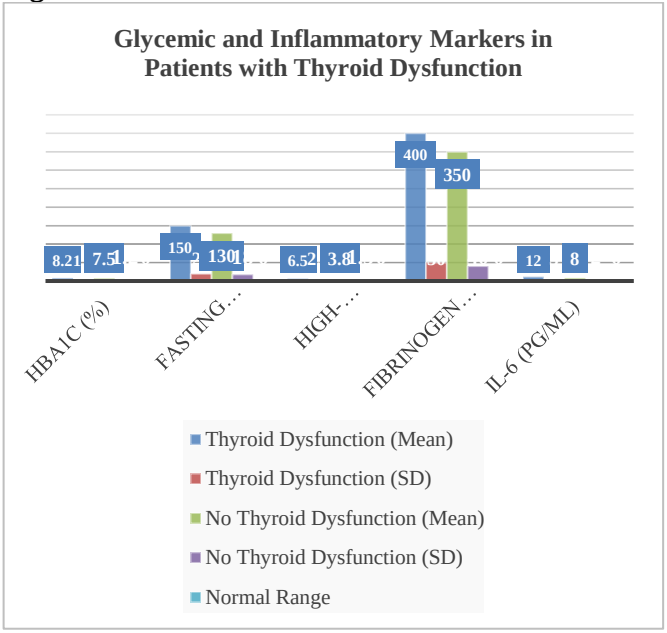
Patients with thyroid dysfunction had worse glycemic control and elevated inflammatory markers compared to those without thyroid issues. The mean HbA1c level was 8.2% in the thyroid dysfunction group, higher than the 7.5% observed in euthyroid patients. Fasting glucose levels were also elevated (150 mg/dL vs. 130 mg/dL). Inflammatory markers, including high-sensitivity CRP (6.5 mg/L vs. 3.8 mg/L) and fibrinogen (400 mg/dL vs. 350 mg/dL), were significantly higher in thyroid dysfunction patients. Interleukin-6 (IL-6), a marker of systemic inflammation, was also elevated (12 pg/mL vs. 8 pg/mL), further illustrating the pro-inflammatory state associated with thyroid dysfunction.

Table 6

Glycemic and Inflammatory Markers in Patients with Thyroid Dysfunction

Marker	Thyroid Dysfunction (Mean ± SD)	No Thyroid Dysfunction (Mean ± SD)	Normal Range
HbA1c (%)	8.2 ± 1.4	7.5 ± 1.2	<7
Fasting Glucose (mg/dL)	150 ± 20	130 ± 18	<126
High-Sensitivity CRP (mg/L)	6.5 ± 2.1	3.8 ± 1.5	<3
Fibrinogen (mg/dL)	400 ± 50	350 ± 40	<400
IL-6 (pg/mL)	12 ± 3	8 ± 2	<10

Figure 2



DISCUSSION

This study highlights the significant impact of thyroid dysfunction on cardiovascular risk in patients with type 2 diabetes mellitus (T2DM). Thyroid disorders, affecting 40% of the cohort, were associated with poor glycemic control, dyslipidemia, increased arterial stiffness, elevated inflammatory markers, and structural changes in the heart, suggesting a higher cardiovascular burden in these individuals. The findings underscore the importance of early detection and management of thyroid dysfunction in T2DM patients to reduce cardiovascular risks and improve overall health outcomes. The prevalence of thyroid dysfunction in this study was found to be 40%, with hypothyroidism being the most common disorder [7,8]. This is consistent with previous research, which has shown that thyroid dysfunction, particularly hypothyroidism, is more prevalent in diabetic patients compared to the general population. The high prevalence of thyroid disorders in the T2DM cohort may be due to the complex interplay between thyroid hormones and glucose metabolism [9]. The findings emphasize the need for routine thyroid function screening in T2DM patients, as subclinical thyroid dysfunction may go undiagnosed and contribute to worsening cardiovascular risk [10]. The study reveals that patients with thyroid dysfunction had significantly worse lipid profiles, including higher LDL cholesterol, total cholesterol, triglycerides, and lower HDL cholesterol levels. These alterations in lipid metabolism are well-documented in both hypothyroid and hyperthyroid states. Hypothyroidism is particularly associated with an increased risk of atherosclerosis due to elevated LDL and triglyceride levels, while hyperthyroidism can lead to arrhythmias and tachycardia, further complicating cardiovascular health. Additionally, elevated lipoprotein(a) levels in these patients suggest an added layer of risk for atherosclerotic cardiovascular disease, which aligns with other studies that have linked thyroid dysfunction to elevated lipoprotein(a) concentrations [11].

Arterial stiffness, a marker of vascular health, was observed in 60% of patients with thyroid dysfunction. This is concerning, as increased arterial stiffness is associated with a higher risk of hypertension, heart failure, and ischemic heart disease. In fact, 70% of patients with thyroid dysfunction had hypertension, and left ventricular hypertrophy (LVH) was present in 45% of cases [12]. These findings are consistent with the literature, which indicates that thyroid dysfunction can contribute to endothelial dysfunction and the development of atherosclerosis. The increased vascular stiffness and inflammatory burden in these patients may contribute to the progression of cardiovascular disease. The study also found significant structural changes in the hearts of patients with thyroid dysfunction, including reduced left ventricular ejection fraction (LVEF) and increased left ventricular mass index (LVMI), compared to euthyroid individuals [13]. These findings suggest that thyroid dysfunction can exacerbate diastolic dysfunction and left ventricular remodeling, both of which are precursors to heart failure. The higher prevalence of elevated pulmonary artery pressure in the thyroid dysfunction group (35 mmHg vs. 25 mmHg) further points to the cardiac burden in these patients. Patients with thyroid dysfunction also had poorer glycemic control, as evidenced by higher HbA1c levels and elevated fasting glucose levels. This aligns with the established role of thyroid hormones in glucose metabolism, with hypothyroidism being associated with reduced insulin sensitivity and hyperthyroidism potentially increasing insulin resistance. The increased inflammatory markers, such as CRP, fibrinogen, and IL-6, further highlight the systemic inflammation linked to thyroid dysfunction, which could contribute to both poor glycemic control and cardiovascular disease progression [14].

The findings of this study suggest that thyroid dysfunction is a significant modifiable risk factor for cardiovascular complications in T2DM patients [15]. The presence of thyroid disorders in these individuals exacerbates several cardiovascular risk factors, including dyslipidemia, hypertension, and arterial stiffness, while also impairing glycemic control. Early detection and management of thyroid dysfunction in T2DM patients could play a crucial role in mitigating these cardiovascular risks and improving patient outcomes. Clinicians should consider routine screening for thyroid dysfunction in T2DM patients, particularly in those with unexplained changes in lipid profiles or worsening cardiovascular health [16]. While this study provides valuable insights, there are some limitations to consider. The cross-sectional design limits the ability to establish causality, and the study was conducted at a

single center, which may affect the generalizability of the findings. Future longitudinal studies are needed to assess the long-term impact of thyroid dysfunction on cardiovascular outcomes in T2DM patients. Additionally, exploring the effects of thyroid hormone replacement therapy on cardiovascular risk in this population could provide further evidence for therapeutic interventions.

CONCLUSION

Thyroid dysfunction is a prevalent and significant risk factor for cardiovascular complications in patients with type 2 diabetes mellitus (T2DM). This study demonstrated that thyroid disorders, particularly hypothyroidism, are associated with poor glycemic control, dyslipidemia, increased arterial stiffness, and structural cardiac abnormalities, all of which contribute to a heightened cardiovascular risk. Early detection and appropriate management of thyroid dysfunction in T2DM patients could mitigate these risks and improve overall cardiovascular outcomes.

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