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Thyroid Dysfunction, Remodeling, and Trends in Dysfunctional Thyroid Between People with Diabetes Mellitus Type 1 And Type 2

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ABSTRACT

Background: Diabetes mellitus and thyroid dysfunction are two of the most prevalent endocrine disorders across globe, and concurrence of them may cause worsening metabolic control and increased morbidity. Thyroid hormone changes differ among types of diabetes, gender, and related biochemical derangements.

Objective: Aim This study was to assess the thyroid function and frequency of thyroid dysfunction in type 1 diabetes mellitus (T1DM) and type 2 diabetes mellitus (T2DM) patients compare to non-diabetic clinic controls.

Methods: It is a case-control study carried on two hundred participants, from them one hundred controls and one hundred patient in the Diabetes Center in Al-Sadr General Hospital in Najaf Al-Ashraf in the period from May 2025 to August 2025. This study consisted of 50 patients of type 1 diabetes mellitus, 50 patients of type 2 diabetes mellitus and 100 non- diabetic controls. Thyroid function was determined by serum levels of thyroid-stimulating hormone, free triiodothyronine and free thyroxine. Furthermore, laboratory investigations such as fasting blood glucose, postprandial blood glucose, glycated hemoglobin, lipid Profile, serum urea, creatinine and urinary microalbumin were studied by standard laboratory techniques.

Results: Of the groups studied, thyroid hormone levels differed significantly. In patients with type 2 diabetes mellitus, thyroid-stimulating hormone was elevated and free triiodothyronine and free thyroxine levels were reduced to a greater degree in females, indicating a more hypothyroid pattern. In comparison, at the opposite end of the spectrum, type 1 diabetes mellitus patients had higher free thyroid hormone levels (specifically FT3 and FT4) and lower TSH values, suggesting the potential for hyperthyroid function to be a problem. About half of the patients with type 2 diabetes mellitus (more frequently females) had a higher prevalence of hypothyroidism, while the frequency of hyperthyroidism was greater in females with type 1 diabetes mellitus. Patients with diabetes also showed a significantly higher fasting blood glucose, postprandial blood glucose, glycated hemoglobin and lipid profile disorders compared with the controls.

Conclusions: The results show that thyroid function is profoundly altered in diabetic patients, being that differences are presented regarding type 1 and type 2 diabetes. Hypothyroid changes were more often associated with type 2 diabetes mellitus, especially in females, whereas type 1 diabetes mellitus was associated with a trend towards hyperthyroid changes. In conclusion, routine thyroid function screening is clinically useful to facilitate case finding for early diagnosis and better disease management in diabetic patients.

KEYWORDS: Diabetes mellitus; Type 1 diabetes; Type 2 diabetes; Thyroid dysfunction; TSH; FT3; FT4; Hypothyroidism; Hyperthyroidism.

1. INTRODUCTION

Diabetes mellitus (DM) is one of the most common chronic metabolic disorders worldwide and is characterized by persistent hyperglycemia resulting from impaired insulin secretion, reduced insulin action, or both [1]. The global prevalence of diabetes has increased markedly during recent decades, making it a major public health challenge because of its association with cardiovascular disease, chronic kidney disease, neuropathy, retinopathy, and premature mortality [1]. Diabetes is mainly classified into type 1 diabetes mellitus (T1DM) and type 2 diabetes mellitus (T2DM). Type 1 diabetes is caused by autoimmune destruction of pancreatic β-cells, leading to absolute insulin deficiency, whereas type 2 diabetes is primarily associated with insulin resistance and progressive β-cell dysfunction [2]. thyroid dysfunction is another common endocrine disorder and may present as hypothyroidism, hyperthyroidism, or subclinical hormonal abnormalities. Thyroid hormones play an essential role in the regulation of basal metabolic rate, lipid metabolism, glucose utilization, thermogenesis, growth, and cardiovascular function [3]. Even mild disturbances in thyroid hormone balance may lead to clinically important metabolic consequences [4]. several studies have demonstrated a close relationship between diabetes mellitus and thyroid dysfunction. Thyroid abnormalities are reported more frequently among diabetic

patients than in the general population [5,6]. This relationship is clinically important because thyroid dysfunction may adversely affect glycemic control, insulin sensitivity, body weight, and serum lipid profile, thereby increasing the risk of diabetic complications [7]. the association between diabetes and thyroid dysfunction differs according to the type of diabetes. In T1DM, autoimmune thyroid disease is more common because of shared genetic susceptibility and immune-mediated mechanisms. Autoimmune thyroiditis and Graves' disease occur more frequently in patients with T1DM than in non-diabetic individuals [8]. in contrast, thyroid dysfunction in T2DM is more commonly related to insulin resistance, obesity, chronic inflammation, altered deiodinase activity, and disturbances in the hypothalamic–pituitary–thyroid axis [9].

Hypothyroidism is considered the most frequent thyroid abnormality reported in patients with T2DM and may worsen insulin resistance and dyslipidemia [10]. sex and age may also influence the prevalence of thyroid dysfunction in diabetic populations. Previous studies reported that female diabetic patients are more likely to develop thyroid abnormalities, particularly hypothyroidism, than males [11]. Advancing age has also been associated with a higher frequency of thyroid dysfunction, especially among patients with T2DM [12]. because many thyroid abnormalities remain subclinical, routine thyroid function screening in diabetic patients may be beneficial for early diagnosis and timely management. Measurement of thyroid-stimulating hormone (TSH), free triiodothyronine (FT3), and free thyroxine (FT4) may help identify patients at risk and improve clinical outcomes.therefore, the present study aimed to investigate thyroid hormone profiles and the frequency of thyroid dysfunction among patients with type 1 and type 2 diabetes mellitus compared with non-diabetic controls in Najaf Al-Ashraf, Iraq.

2. METHODOLOGY

2.1 Study Design and Participants

This case-control study included 200 participants recruited from the Diabetes Center at Al-Sadr General Hospital, Najaf Al-Ashraf, Iraq, between May and August 2025. The study population consisted of three groups: 50 patients with type 1 diabetes mellitus (T1DM), 50 patients with type 2 diabetes mellitus (T2DM), and 100 apparently healthy non-diabetic controls. patients were considered diabetic based on a documented medical diagnosis of diabetes mellitus supported by biochemical evidence of persistent hyperglycemia according to established diagnostic criteria. The control group included individuals without a previous history of diabetes mellitus and with normal glycemic parameters

2.2 Data Collection

Demographic and clinical data were obtained using a structured questionnaire. Information collected included age, sex, smoking status (non-smoker, former smoker, or current smoker), menopausal status (premenopausal, postmenopausal, surgical menopause, or contraceptive use), and selected dietary habits.

2.3 Laboratory Investigations

Venous blood samples were collected under standard aseptic conditions after overnight fasting. Serum thyroid-stimulating hormone (TSH), free triiodothyronine (FT3), and free thyroxine (FT4) were measured using chemiluminescent immunoassay methods. in addition, fasting blood glucose (FBG), postprandial blood glucose (PPBG), glycated hemoglobin (HbA1c), lipid profile, serum urea, creatinine, and urinary microalbumin were measured according to standard laboratory procedures. participants were classified as hypothyroid, hyperthyroid, or euthyroid according to the reference ranges recommended by the assay manufacturer and interpreted by laboratory standards.

2.4 Statistical Analysis

Statistical analysis All the statistical analyses were made using IBM SPSS Statistics 25.0 (IBM Corp., Armonk, NY, USA). Continuous variables were reported as mean ± standard deviation (SD) and categorical variables as frequencies and percentages. data normality was assessed with the Shapiro–Wilk test. Group comparisons of continuous variables between the three study groups were performed with one-way analysis of variance (ANOVA), and Tukey's post hoc test for multiple comparisons when appropriate for type 1 diabetes mellitus, type 2 diabetes mellitu, and control group. act Pancreas—the Pancreatic Cancer Research Group at the University of Hull Independent samples Student's The models that were treated with thecommercial grade were compared to those treated with thebiggest strain size and beyond were allocated to thehigh category, whereas balls heavier than200 g were assigned to thehairballs wood classified aslight. Categorical variables such as the frequency of thyroid dysfunction patterns, were compared using chi-square test or Fisher's exact test when the expected cell counts were less than five. correlations between thyroid hormone parameters and biochemical variables (i.e., fasting blood glucose, glycated hemoglobin [HbA1c], and lipid profile) were assessed using Pearson's correlation coefficient or Spearman's rank correlation test, according to data distribution. all tests were two-tailed, a P-value <0.05 was considered statistically significant.

3. RESULTS

3.1 Participant Characteristics and Biochemical Findings

The present study included 200 participants divided into three groups: 50 patients with type 1 diabetes mellitus (T1DM), 50 patients with type 2 diabetes mellitus (T2DM), and 100 non-diabetic controls. The T1DM group included 27 males and 23 females, while the T2DM group included 25 males and 25 females. The control group consisted of 50 males and 50 females. the mean age showed a statistically significant difference among the study groups ($P < 0.001$). Patients with T1DM were younger than those with T2DM and controls. Glycemic indices, including fasting blood glucose, postprandial blood glucose, and glycated hemoglobin (HbA1c), were significantly higher in diabetic patients than in controls ($P < 0.001$). regarding lipid parameters, diabetic patients had significantly higher total cholesterol, triglycerides, and low-density lipoprotein cholesterol (LDL-C) levels, whereas high-density lipoprotein cholesterol (HDL-C) levels were significantly lower compared with controls. Serum creatinine levels were also significantly elevated in diabetic groups, particularly among patients with T2DM ($P < 0.01$).

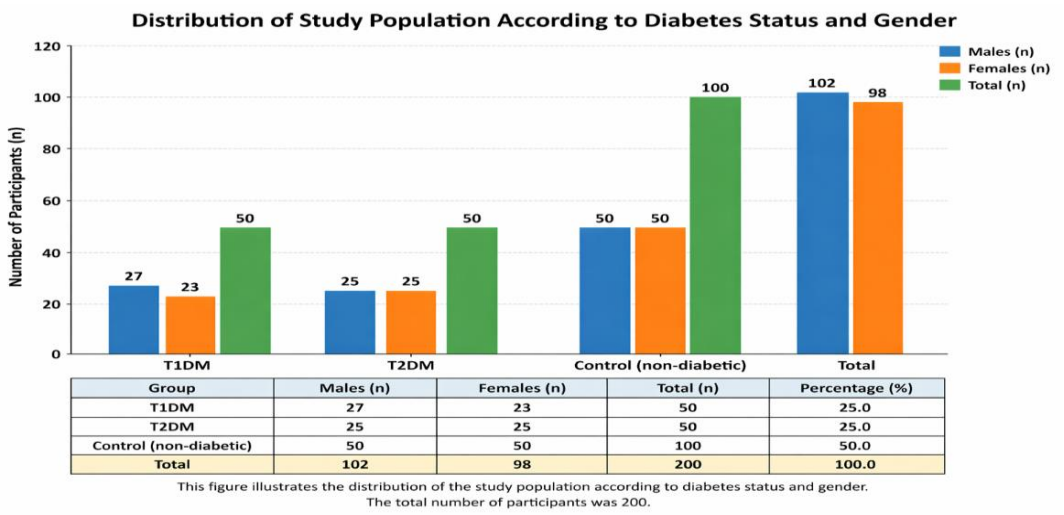

Figure 1. Distribution of study population according to diabetes status and gender
The control group represented 50% of the total sample, while T1DM and T2DM each represented 25%

Table 1. Detailed demographic and biochemical characteristics of the study participants are presented in

Variable	T1DM (n=50)	T2DM (n=50)	Control (n=100)	P-value
Age (years)	22.5 ± 4.2	49.6 ± 9.8	48.9 ± 10.1	<0.001
Male/Female	27/23	25/25	50/50	0.45
Fasting blood glucose (mg/dL)	190.2 ± 35.1	156.4 ± 38.2	92.6 ± 10.4	<0.001
2-hour PPBG (mg/dL)	260.3 ± 45.2	232.8 ± 54.1	118.3 ± 18.6	<0.001
HbA1c (%)	9.8 ± 1.3	8.4 ± 1.2	5.4 ± 0.4	<0.001
Total cholesterol (mg/dL)	185.4 ± 30.2	198.6 ± 36.7	172.4 ± 28.9	<0.01
Triglycerides (mg/dL)	160.3 ± 40.5	184.2 ± 62.5	132.6 ± 44.1	<0.01
HDL-C (mg/dL)	42.1 ± 7.5	38.4 ± 8.2	46.9 ± 9.1	<0.01
LDL-C (mg/dL)	110.2 ± 25.3	118.6 ± 31.4	98.2 ± 24.6	<0.01
Serum creatinine (mg/dL)	1.05 ± 0.25	1.18 ± 0.32	0.92 ± 0.21	<0.01

3.2 Thyroid Hormone Profiles and Thyroid Dysfunction Patterns

Significant differences were observed in thyroid hormone parameters among diabetic subgroups. Patients with T2DM, particularly females, had higher thyroid-stimulating hormone (TSH) levels with lower free triiodothyronine (FT3) and free thyroxine (FT4) levels, indicating a stronger tendency toward hypothyroid changes. the highest mean TSH level was recorded among females with T2DM (6.2 ± 1.1 mIU/L), while the lowest FT3 and FT4 values were also observed in this subgroup. In contrast, patients with T1DM showed relatively lower TSH levels and higher FT3 and FT4 concentrations, suggesting a tendency toward hyperthyroid patterns. hypothyroidism was most frequent among females with T2DM (44.0%), whereas hyperthyroidism was more commonly observed among females with T1DM (26.1%). Euthyroid status was more common among male diabetic patients. Detailed thyroid hormone findings are shown in table 2**.**

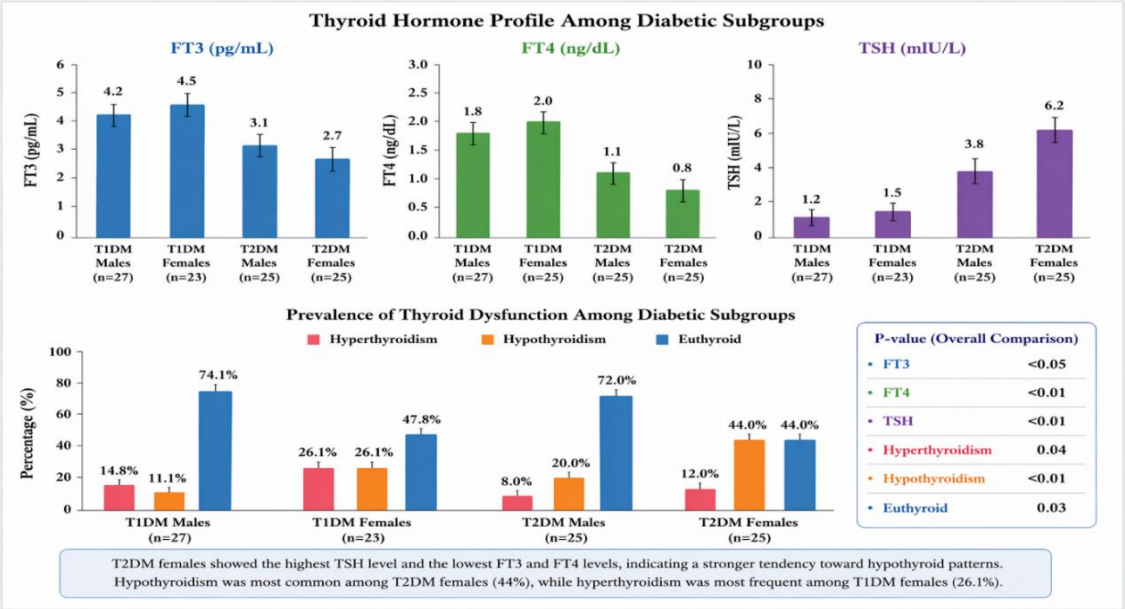

Figure 2. Thyroid hormone profile and prevalence of thyroid dysfunction among diabetic subgroup Thyroid hormone profile and prevalence of thyroid dysfunction among diabetic subgroups

Table 2. Thyroid Hormone Profiles and Thyroid Dysfunction Patterns Among Diabetic Subgroups

Parameter	T1DM males (n=27)	T1DM females (n=23)	T2DM males (n=25)	T2DM females (n=25)	P-value
FT3 (pg/mL)	4.2 ± 0.5	4.5 ± 0.6	3.1 ± 0.3	2.7 ± 0.3	<0.05
FT4 (ng/dL)	1.8 ± 0.3	2.0 ± 0.3	1.1 ± 0.2	0.8 ± 0.2	<0.01
TSH (mIU/L)	1.2 ± 0.4	1.5 ± 0.5	3.8 ± 0.6	6.2 ± 1.1	<0.01
Hyperthyroidism (n, %)	4 (14.8%)	6 (26.1%)	2 (8.0%)	3 (12.0%)	0.04
Hypothyroidism (n, %)	3 (11.1%)	6 (26.1%)	5 (20.0%)	11 (44.0%)	<0.01
Euthyroid (n, %)	20 (74.1%)	11 (47.8%)	18 (72.0%)	11 (44.0%)	0.03

4. DISCUSSION

Introduction (Aim) The present study showed a significant changes in thyroid function in patient diagnosed with diabetes mellitus more in type 1 diabetes mellitus (T1DM) when compared to type 2 diabetes mellitus (T2DM). Consistent with previous reports, these findings suggest a close linkage between diabetes and thyroid dysfunction in affected populations [13]. higher TSH levels with lower FT3 and FT4 concentrations, as well as a more prominent trend toward hypoyhodroid patterns were especially evident in female patients with T2DM in the current study. Similar results were show in previous studies reporting hypothyroidism among T2DM patients [14,15]. These changes of hormonal regulation may associate with insulin resistance, obesity, chronic low-grade inflammation, and disturbed thyroid hormone metabolism [16]. current study showed a higher prevalence of hypothyroidism in female patients with T2DM. This finding corroborates earlier reports that thyroid dysfunction is more prevalent in women likely due to hormonal and autoimmune factors [17]. Older age also possibly adds to the increased occurrence of thyroid dysfunction in female ones with diabetes [18]. however, patients with T1DM in the present study had higher FT3 and FT4 values with lower TSH concentrations compared with controls, indicating hyperthyroid-like changes. The autoimmune nature of T1DM and its tendency to exist in autoimmunity with autoimmune thyroid disease could account for this. Autoimmune thyroid disorders have been previously shown to be one of the most common endocrine comorbidities in patients with T1DM [19,20]. collectively, the present study similarly illustrated highly increased fasting blood glucose, postprandial blood glucose and glycated hemoglobin (HbA1c) in diabetic patients versus controls. Impaired glucose control is able to affect the metabolism of thyroid hormones, and inherent thyroid dysfunction may further exacerbate glucose regulation. Hyperthyroidism can increase hepatic insulin production and aggravate insulin degradation and hypothyroidism decreases peripheral glucose utilization and creates an insulin resistance [21]. lipid disorders were more prevalent in diabetic groups and especially in T2DM patients. Elevated total cholesterol and triglycerides as well as low-density lipoprotein cholesterol (LDL-C) concentrations and reduced high-density lipoprotein cholesterol (HDL-C) concentrations are prominent cardiovascular risk factors associated with diabetes mellitus, which can be worsened by hypothyroidism [22,23]. the

clinical relevance of these findings is that thyroid dysfunction may go unrecognized for extended periods of time, particularly in women with diabetes mellitus who have T2DM and with patients who do not achieve adequate glycemic control. Thus, regular thyroid screening with serum TSH, FT3, and FT4 measurements could be of assistance in timely diagnosis and metabolic control [24,25]. Some limitations should be acknowledged. The study was of moderate size and single center. Thyroid autoantibodies and thyroid ultrasonography were not assessed, which might have provided more evidence of autoimmune thyroid disease. Multicenter studies with larger populations are warranted in the future. to summarize, the present results corroborate an important correlation between diabetes mellitus and thyroid disease. Hypothyroid patterns were seen more associated with T2DM whereas hyperthyroid changes were seen in T1DM. These findings underline the importance of including thyroid function evaluation to diabetic routine care.

5. CONCLUSION

The currently study showed a significant relation between diabetes mellitus and thyroid dysfunction with a clear hormonal pattern between type 1 and type 2 of diabetes mellitus. Patients with type 2 diabetes mellitus, especially females, had a statistically significant higher tendency for becoming hyperthyroid characterized by higher thyroid-stimulating hormone levels and lower free triiodothyronine and free thyroxine levels. However, hyperthyroid changes were apparent in patients with type 1 diabetes mellitus. thyroid status and metabolic regulation in patients with diabetes also influenced glycemic control and lipid alterations in diabetic patients poorer than in non-diabetic controls. Conclusion The results suggest that undiagnosed thyroid impairment lead to poorer metabolic profiles in diabetic individuals. regular evaluation of thyroid function may facilitate early identification and prompt management, particularly amongst young women with type 2 diabetes mellitus and individuals displaying poor glycaemic control. Additional multicenter studies with larger sample sizes are needed to verify our results and explain the pathophysiology connecting diabetes mellitus with thyroid dysfunction

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