

## Evaluation of thyroid hormones in type 1 diabetes mellitus

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### Abstract

**Background and objective:** Increased blood sugar levels (hyperglycemia) and lack of insulin are a hallmark of Type 1 diabetes mellitus (T1DM), which is a chronic autoimmune illness results from the destruction of pancreatic beta –cells. The most common causes of hypothyroidism and hyperthyroidism are autoimmune diseases Hashimoto's thyroiditis and Graves' disease, respectively. Because type 1 diabetes includes autoimmunity as a pathophysiological trigger, it is not uncommon to investigate patients with both diabetes and thyroid problems. The aim of the study is to evaluate serum thyroid hormones in patients with type1 diabetes mellitus.

**Methods:** In this study 104 participants were included, 52 patients with type1 diabetes, and 52 healthy individuals. Blood samples were taken, and serum thyroid hormones levels were measured and the results of cases and controls were analyzed and compared using SPSS program.

**Results:** It was found that the levels of T4 among non- diabetic participants were higher than those of diabetic patients. ( $P < 0.001$ ). There is a negative correlation between BMI and fasting blood glucose in T1 diabetic patients according to regression test it has been shown that any increase in the FBG leads to decrease in the BMI.

**Conclusion:** The present study shows that type 1 diabetes mellitus may affect thyroid gland and thyroid hormone levels, that may result in thyroid dysfunction.

**Keywords:** Thyroid hormones (T3 and T4); TSH; Type 1 diabetes mellitus.

### Introduction

Type 1 diabetes mellitus (T1DM) and Autoimmune thyroid disease (AITD) both endocrine diseases that are highly related to each other.<sup>1</sup> According to limited data, the prevalence of subclinical hypothyroidism ranges from 7 to 20%.<sup>2</sup> Comparing to 1-10% in adults to 2-6% in children. in the general population. Hyperthyroidism is considerably more common in patients with T1DM (3 to 6%), compared to 0.1 to 2.0% in the healthy people. Thyroid autoimmunity affects 15–30% of adults and 5–22% of children, which is greater than in the non-diabetic individuals (2 to 10 percent and 1 to 4 percent, respectively). Female gender,

advanced age, and diabetes for a longer period of time all give a higher risk.<sup>3</sup>

Thyroid autoimmunity is most common in young people between early to mid-puberty, and in adults, it is most common in middle-aged women. Seroconversion to thyroid peroxidase antibodies in children at genetic risk of Type 1 diabetes rises around puberty,<sup>4</sup> when the thyroid gland experiences restructuring. This is later than islet seroconversion, indicating that the environmental trigger for thyroid autoimmunity is distinct. At the time of Type 1 diabetes diagnosis, or years or decades after the diagnosis,<sup>4</sup> biochemical thyroid dysfunctions may be evident.

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Prior to the onset of thyroid dysfunction, there may be a protracted period of thyroid autoimmunity, although it is unknown if Type 1 diabetes patients proceed to clinical disease more quickly than the general population. Hypoglycemia and poor glycemic control are all symptoms of untreated hypothyroidism.<sup>5</sup> Additionally, glycemic control may deteriorate as a result of hyperthyroidism,<sup>6</sup> and cardiovascular risk. However, it is uncertain if screening for and early diagnosis of thyroid disease leads to better clinical results.<sup>7</sup>

Indeed, TPOAb was reported to be present in a higher proportion of individuals with T1DM who were positive for pancreatic islet beta-cell antibodies, insulin antibodies, and anti-glutamic acid decarboxylase antibodies (GADAbs), which are commonly used to diagnose T1DM.<sup>8,9</sup> As a result, AITD is considered the most common T1DM-related autoimmune disorder.<sup>8</sup> In the field of endocrinology, thyroid disorders and diabetes are the two most prevalent illnesses, and they are both interconnected.<sup>10</sup> Patients with T1DM or T2DM may have impaired thyroid function, according to studies.<sup>11,12</sup> Thyroid hormones not only assist tissues to grow and develop, but they can also have an impact on how sugar is metabolized.<sup>13</sup>

When T1DM patients experience hyperglycemia, insulin production is generally insufficient, the body's glucose metabolism activity is reduced, thyroid follicular cells consume less energy, which results in iodine pump malfunction, and the thyroid's response to TSH is diminished.<sup>14,15</sup> Reduced thyroid hormones synthesis impacts the activity of 5'-deiodinase, which in turn lowers FT3 levels.<sup>16</sup> The body experiences a clear metabolic imbalance when blood glucose is not properly managed for an extended period of time, which may have an indirect impact on how the hypothalamus pituitary thyroid axis system operates. The secretion of TSH is reduced as a result of insensitivity.<sup>17</sup> The aim of this study is to investigate the levels of thyroid hormones

in T1 diabetic patients.

## Methods

**Design:** This study was conducted at Layla Qasim diabetes center in Erbil City, 52 samples were collected from patients with type 1 diabetes mellitus and compared with 52 samples of non-diabetic individuals. Blood collection and analyzing carried out from October 2021 to February 2022. 104 participants were included in the study 52 cases and 52 controls. Both groups consist of (35 Females and 17 Males). All patients in the study were between 4 and 65 years of age.

Patients with type 1 diabetes mellitus were included, while patients with other types of diabetes such as type 2 and gestational diabetes were excluded from this study. Information of participants were taken by filling a questionnaire paper which included questions about (age, gender, marital status, and their educational attainments), in addition the weight and length in order to obtain their body mass index (BMI). Family history and the onset of the disease as well as the life style such as diet, and exercise were a part of the questionnaire.

**Blood collection:** Blood samples were collected using phlebotomy procedure by specialists. Withdrawal of 7 ml of blood by disposal needles. Samples collected in two tubes one of them is EDTA for HbA1c estimation, while gel tube used to estimate thyroid hormones. Serum was separated from blood by a centrifuge for 6 minutes at a speed of 5000rpm, then the separated serum was preserved in Eppendorf tubes at -20 °C for measuring thyroid hormones (TSH, T3, and T4) levels.

**Statistical Analysis:** Data were expressed as Mean ± Std. The Statistical Package for Social Sciences (SPSS program Version 24) was used in analysis. Independent t-test used to compare between cases and controls. Chi-square is used for categorical variables. And Pearson correlation test was used to evaluate the strength of the correlation between body mass index and blood sugar levels among type 1 diabetic

patients. *P*-values < 0.05 were considered to indicate a statistically significant results.

**Results**

It is obvious from Table 1 that the females are more prone to get T1DM than males, in which 67% of participants were females while 32% of them were males. Regarding to BMI it was shown that patients with T1DM have lower BMI than non-diabetic participants. The average age of people who have a risk of getting T1DM is around 20 years' old.

**Serum T4, T3, and TSH:**

In this study Mean ± Standard Deviation (SD) of T4 was (116.44± 16.76) for type1 diabetic patients, while in control group was (136.22±24.67) with *P*-value of (<0.001) which implies that the variances are not equal. Consequently, indicating that the differences are statistically significant between type1 diabetic and non-diabetic individuals. On the other hand, the Mean± SD of T3 levels in the case group was

(2.13±1.23) and *P*-value of (0.238), and (1.91±0.40) was the value of control group; this reveals that the differences are not statistically significant. As a result, the result of T3 for the control group and case group is not statistically significant. The TSH's M± SD of diabetic patients was (4.59±13.73), and (2.70± 3.26) for non-diabetic participants, and the *P*-value was equal to (0.340); which means that there are no statistical differences in TSH between case and control groups as it is illustrated in Table 2.

**Body mass index (BMI)- Fasting Blood sugar relationship among type 1 diabetic patients:**

Based on the correlation coefficient between BMI and Blood Sugar, our result of *r* = -0.331 indicates that there is a strong negative significant correlation between BMI and FBS of T1 diabetic patients. Elevation in the blood glucose levels leads to descending in the BMI. As it is illustrated in Table 3.

**Table 1** Demographic features of patients with T1DM and non-diabetic individuals

Characteristic	Case	Control	<i>P</i> -Value
<b>Gender</b>			
Males	17 (32%)	17 (32%)	1.000*
Females	35 (67%)	35 (67%)	
<b>Age (years) Mean ±SD</b>	20.79±13.051	20.96 ±13.03	1.000**
<b>BMI (Kg/m<sup>2</sup>) Mean ±SD</b>	21.983±5.1858	25.66±5.88	0.001**

\*By Chi-square. \*\*By t test

**Table 2** The comparison of serum T3, T4, and TSH levels between type1 diabetes and non-diabetic individuals

Parameters	Case	Control	t-test	<i>P</i> -value
T3	2.13±1.23	1.91±0.40	-0.22	0.238
T4	116.44±16.76	136.22±24.67	19.77	<0.001
TSH	4.59±13.73	2.70±3.26	-1.89	0.340

**Table 3** Regression test for BMI-Blood Sugar (Fasting) in type 1 diabetes patients

Relationship	<i>r</i>	<i>P</i> -value
BMI-Fasting blood sugar	-0.331	0.040

## Discussion

This study was conducted to identify if there is any association between thyroid hormone levels and T1DM. T1DM causes (5 to 10%) of cases of diabetes and is caused by the autoimmune attack of pancreatic beta-cells.<sup>18</sup> T1DM patients are more likely to acquire additional autoimmune diseases including Graves' disease or Hashimoto thyroiditis. AITD and T1DM are associated target-organ autoimmune disorders, with AITD occurring in 17% - 30% of individuals with T1DM an elevated risk of both (Hyperthyroidism and Hypothyroidism). The results of our study showed that females are more prone to get type 1 diabetes mellitus than males in a percentage of (67%) and (32%) respectively (Table 1). This result is in line with a study conducted by Ali, et al (2021), they found that (41.07%) of T1DM patients were male and (58.93%) were female.<sup>19</sup>

Type 1 diabetes mellitus has an obvious impact on the BMI, as the results of this study revealed that the BMI of patients with T1DM lower than of healthy people. As it is illustrated in (Table 3), we found that BMI of patients with type one diabetes is decreases as much as the blood glucose increases, and that explains why do patients with T1DM have lower BMI compared with healthy individuals and/or patients with T1DM. The *P*-value equals to (0.04) indicating a high statistical correlation between BMI and FBS. Also we found that T1DM may effect on thyroid hormones, in the present study the level of serum T4 was higher in diabetic patients comparing with healthy individuals, as the  $M \pm SD$  equals to (116.44±16.76) for cases and (136.22±24.67) for control, *P*-vale <0.001. on the other hand, TSH, and T3 were under normal range, TSH with  $M \pm SD$  of (4.59±13.73) for diabetic patients and (2.70±3.26) for non- diabetic participants, a *p*-value of TSH = (0.340), and (0.238) for T3.

These results are incompatible to the study conducted by Peters et al.<sup>20</sup> in Australia, which revealed that 0.9% of T1DM patients

had subclinical hyperthyroidism, that is defined as serum TSH levels outside the normal reference range with normal levels of fT4 and fT3. A study done by Fatima.<sup>21</sup> et al in Pakistan showed that 41.3% of patients with T1DM have sub-clinical hypothyroid which is not correspond to our study.

Another study carried out by (Iweka et al, 2020) revealed that The thyroid profiles of diabetic patients show a significant decrease (*P* <0.05) for TSH in comparison with the control group, but no significant differences (*P* >0.05) were observed for the thyroid hormones (T3 and T4).<sup>22</sup>

Elevated TSH level among patients with T1DM may be brought on by medications they take that lower fT4 and T4 levels while raising levels of TSH, insulin, which raises T4 levels while lowering T3 levels by inhibiting hepatic conversion of T4 to T3, autoimmune diseases, which are a potential third cause, and thyroid antibodies, which are frequently present in patients with T1DM. In addition, the presence of thyroid hormone binding inhibitors (inhibitors of T4 to T3 conversion), dysfunction in the hypothalamopituitary thyroid axis, and the effects of poorly controlled diabetes on thyroid hormone concentration may contribute to the elevated levels of TSH in T1DM.<sup>23</sup>

## Conclusion

Type 1 diabetes mellitus is associated with thyroid dysfunction. increased level of T4 in type 1 diabetic patients indicate the risk of hyperthyroidism or (Graves' disease). Therefore it is recommended to regularly check thyroid function for type 1 diabetic patients.

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Not applicable.

## Competing interests

The authors declare that they have no competing interests.

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