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Original Research Article

# Association of Glycemic Control and Body Mass Index with Thyroid Dysfunction in Newly Diagnosed Type 2 Diabetes Mellitus

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**Abstract**

**Background:** Type 2 diabetes mellitus (T2DM) and thyroid dysfunction frequently coexist and may share metabolic mechanisms involving insulin resistance, adiposity, and altered thyroid hormone activity. Poor glycemic control and obesity have been associated with a greater frequency of thyroid abnormalities in patients with T2DM.

**Aim:** To evaluate the association of glycemic control and body mass index (BMI) with thyroid dysfunction in patients with newly diagnosed T2DM.

**Materials and Methods:** This cross-sectional observational study included 100 patients with newly diagnosed T2DM at, Farookh Academy of Medical Education Hospital & Research Institute, Mysuru, from May 2025 to May 2026. BMI was categorized as normal, overweight, or obese. Glycemic control was assessed using glycated hemoglobin (HbA1c), and thyroid status was determined by serum thyroid-stimulating hormone (TSH), T3, and T4 levels. Associations were assessed using the chi-square test, and correlation analysis was performed between HbA1c and TSH. A p-value <0.05 was considered statistically significant.

**Results:** Thyroid dysfunction was significantly associated with BMI ($\chi^2$=25.481, p=0.001). Obesity was observed in 62.5% of patients with subclinical hypothyroidism and 77.8% with overt hypothyroidism compared with 26.8% of euthyroid patients. Poor glycemic control was also significantly associated with thyroid status ($\chi^2$=16.913, p=0.002); HbA1c ≥7% was present in 68.8% of patients with subclinical hypothyroidism and 77.8% with overt hypothyroidism compared with 26.8% of euthyroid patients. Mean HbA1c was higher in subclinical hypothyroidism (8.72±1.61%) and overt hypothyroidism (8.32±1.41%) than in euthyroid patients (7.27±1.17%). HbA1c showed a significant positive correlation with serum TSH (r=0.356, p<0.001).

**Conclusion:** Higher BMI and poor glycemic control were significantly associated with thyroid dysfunction in newly diagnosed T2DM, particularly with subclinical and overt hypothyroidism. The positive correlation between HbA1c and TSH further suggests an interrelationship between glycemic status and thyroid function. Thyroid function assessment may therefore be particularly useful in newly diagnosed T2DM patients with obesity or inadequate glycemic control.

**Keywords:** Type 2 Diabetes Mellitus; Thyroid Dysfunction; Hypothyroidism; HbA1c; Body Mass Index; Glycemic Control; Thyroid-Stimulating Hormone.

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## Introduction

Type 2 diabetes mellitus (T2DM) and thyroid dysfunction are among the most frequently encountered endocrine disorders and often coexist because of their complex metabolic and hormonal interactions. Thyroid hormones have an important role in regulating energy expenditure, glucose utilization, hepatic gluconeogenesis, lipid metabolism, and insulin sensitivity. Conversely, insulin resistance and persistent hyperglycemia may influence thyroid hormone synthesis, peripheral conversion, and hypothalamic–pituitary–thyroid axis activity. Consequently, the coexistence of thyroid dysfunction in patients with T2DM may adversely influence metabolic control and contribute to an increased burden of diabetes-related complications [1,2]. Thyroid abnormalities

appear to be considerably more frequent among individuals with T2DM than in the general population. A recent systematic review and meta-analysis reported a pooled prevalence of thyroid dysfunction of approximately 20% among adults with T2DM, with subclinical hypothyroidism being the most frequent abnormality.

Importantly, poor glycemic control, particularly HbA1c ≥7%, and central obesity were identified among the factors associated with thyroid dysfunction [3]. These observations suggest that abnormalities in thyroid function may be closely linked to the metabolic phenotype and severity of dysglycemia in T2DM. The relationship between glycemic control and thyroid function is potentially bidirectional. Hypothyroidism may impair glucose disposal and aggravate insulin resistance, whereas hyperthyroidism can increase intestinal glucose absorption, hepatic glucose production, and insulin degradation. At the same time, poorly controlled diabetes may alter thyroid hormone metabolism and influence circulating thyroid-stimulating hormone (TSH) concentrations [3,4]. Indian data have also demonstrated a substantial burden of previously unrecognized thyroid dysfunction among newly diagnosed patients with T2DM, emphasizing the clinical importance of evaluating thyroid status early in the course of diabetes [5].

Body mass index (BMI) represents another important link between thyroid dysfunction and T2DM. Excess adiposity is strongly associated with insulin resistance and T2DM, while alterations in thyroid function can affect basal metabolic rate, thermogenesis, body weight, and adipose tissue metabolism.

Obesity-related hormonal and inflammatory changes may additionally influence the hypothalamic–pituitary–thyroid axis. Thus, the coexistence of increased BMI, inadequate glycemic control, and thyroid dysfunction may represent an interconnected metabolic disturbance rather than independent abnormalities [6, 7].

Despite these associations, information regarding the relationship of both BMI and glycemic control with different patterns of thyroid dysfunction at the time of initial diagnosis of T2DM remains relatively limited, particularly in the Indian clinical setting. Assessment at diagnosis is valuable because it reduces the potential influence of prolonged diabetes duration and long-term antidiabetic therapy on thyroid parameters.

Therefore, the present study was undertaken to evaluate the association of BMI and glycemic control with thyroid functional status in patients with newly diagnosed type 2 diabetes mellitus, with particular emphasis on the relationship between HbA1c, BMI categories, and thyroid functional status.

## Materials and Methods

**Study Design and Setting:** This cross-sectional observational study was conducted in the Department of General Medicine at Farookh Academy of Medical Education Hospital & Research Institute, Mysuru, from May 2025 to May 2026 (01 years duration). Newly diagnosed type 2 diabetes mellitus patients attending the outpatient department or admitted in our hospital were enrolled.

**Study Population and Sample Size:** A total of 100 patients with newly diagnosed type 2 diabetes mellitus were included. The sample size was calculated using the formula (n=Z^2pq/d^2), considering an estimated diabetes prevalence of 7%, a 95% confidence level, and a 5% margin of error.

### Inclusion Criteria

- Patients with newly detected type 2 diabetes mellitus diagnosed according to American Diabetes Association (ADA)
- Patients who provide written informed consent for the study

### Exclusion Criteria

- Patients with previously known thyroid disease, liver failure, acute illnesses such as sepsis, acute myocardial infarction or severe heart failure
- Recent intensive care unit admission
- Pregnancy
- Patients receiving medications known to interfere with thyroid function

**Data Collection and Clinical Assessment:** After obtaining Institutional Ethics Committee approval and written informed consent, eligible participants were enrolled. A detailed clinical history was obtained and a complete clinical examination was performed. Anthropometric assessment included measurement of body mass index (BMI), and participants were categorized as normal BMI (18.5–24.9 kg/m²), overweight (25.0–29.9 kg/m²), or obese (≥30 kg/m²), consistent with the categories used for analysis in the study.

**Assessment of Glycemic Status and Thyroid Function:** Plasma glucose levels were determined using a colorimetric method, whereas glycated hemoglobin (HbA1c) was measured by high-performance liquid chromatography. Diabetes was diagnosed in the presence of fasting plasma glucose ≥126 mg/dL, random plasma glucose ≥200 mg/dL with classical symptoms of hyperglycemia. For evaluation of glycemic control, participants were stratified into two groups based on HbA1c levels:

<7% and ≥7%. Thyroid function was evaluated in all participants by measuring serum thyroid-stimulating hormone (TSH), triiodothyronine (T3), and thyroxine (T4) using an electrochemiluminescence immunoassay. The reference intervals used were 0.4–4.2 µIU/mL for TSH, 70–190 ng/dL for T3, and 5–11 ng/dL for T4. The association between glycemic control and thyroid functional status was subsequently analyzed.

**Outcome Assessment:** The principal outcomes were the associations of thyroid functional status with body mass index (BMI) and glycemic control. The distribution of BMI categories was compared among the different thyroid functional groups. Glycemic control was assessed by comparing HbA1c categories (<7% and ≥7%) as well as mean HbA1c values across thyroid status groups. In addition, the relationship between HbA1c levels and serum TSH was examined.

**Statistical Analysis:** The collected data were analyzed using IBM SPSS Statistics version 29. Categorical variables were summarized as frequencies and percentages, while continuous variables were expressed as mean ± standard deviation. Associations between categorical variables were evaluated using the chi-square test, and continuous variables were compared using the one-way ANOVA, wherever applicable. Correlation analysis was performed to determine the relationship between HbA1c and serum TSH levels. A p-value <0.05 was considered statistically significant.

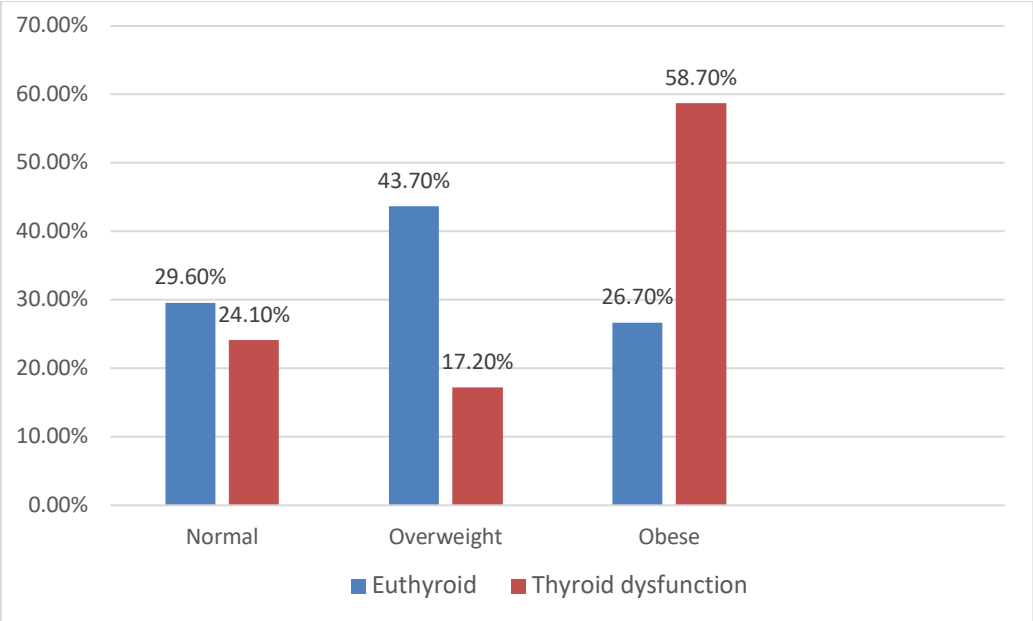
## Results

Thyroid dysfunction showed a significant association with BMI. Obesity was more frequent among patients with subclinical hypothyroidism (62.5%) and overt hypothyroidism (77.8%), whereas euthyroid patients were more commonly overweight (43.7%) [Table: 1].

**Table 1: Distribution of thyroid functional status according to BMI category**

| Thyroid status | Normal n (%) | Overweight n (%) | Obese n (%) | Total |
|---|---|---|---|---|
| Euthyroid | 21 (29.6) | 31 (43.7) | 19 (26.8) | 71 |
| Subclinical hypothyroidism | 3 (18.8) | 3 (18.8) | 10 (62.5) | 16 |
| Overt hypothyroidism | 0 (0.0) | 2 (22.2) | 7 (77.8) | 9 |
| Subclinical hyperthyroidism | 3 (100.0) | 0 (0.0) | 0 (0.0) | 3 |
| Overt hyperthyroidism | 1 (100.0) | 0 (0.0) | 0 (0.0) | 1 |
| **Total** | **28** | **36** | **36** | **100** |

Patients with thyroid dysfunction had a higher proportion of obesity (58.7%) than euthyroid patients (26.8%), while normal BMI and overweight categories were more frequent in the euthyroid group [Table: 1].




**Graph 1: Comparison of BMI categories between euthyroid patients and patients with thyroid dysfunction**

Poor glycemic control (HbA1c ≥7%) was more frequent in subclinical hypothyroidism (68.8%) and overt hypothyroidism (77.8%) than in euthyroid patients (26.8%). The association between glycemic control and thyroid status was statistically significant ($\chi^2$=16.913, p=0.002) [Table: 2]

**Table 2: Distribution of glycemic control according to thyroid functional status**

| Thyroid status | HbA1c <7%, n (%) | HbA1c ≥7%, n (%) | Total |
|---|---|---|---|
| Euthyroid | 52 (73.2) | 19 (26.8) | 71 |
| Subclinical hypothyroidism | 5 (31.2) | 11 (68.8) | 16 |
| Overt hypothyroidism | 2 (22.2) | 7 (77.8) | 9 |
| Subclinical hyperthyroidism | 2 (66.7) | 1 (33.3) | 3 |
| Overt hyperthyroidism | 1 (100.0) | 0 (0.0) | 1 |
| Total | 62 | 38 | 100 |

Mean HbA1c was highest in patients with subclinical hypothyroidism (8.72±1.61%), followed by overt hypothyroidism (8.32±1.41%), and compared with 7.27±1.17% among euthyroid patients [Table: 3].

**Table 3: Mean HbA1c according to thyroid functional status**

| Thyroid status | Mean HbA1c (%) |
|---|---|
| Euthyroid | 7.27 ± 1.17 |
| Subclinical hypothyroidism | 8.72 ± 1.61 |
| Overt hypothyroidism | 8.32 ± 1.41 |
| Subclinical hyperthyroidism | 7.23 ± 0.75 |
| Overt hyperthyroidism | 6.80 |

BMI was significantly associated with thyroid dysfunction (Pearson $\chi^2$=25.481, df=8, p=0.001), indicating a greater burden of thyroid abnormalities with higher BMI categories [Table: 4].

**Table 4: Association between BMI category and thyroid functional status**

| Variables | df | Pearson Chi-Square | p-value |
|---|---|---|---|
| BMI and thyroid dysfunction | 8 | 25.481 | 0.001 |

HbA1c demonstrated a significant positive correlation with serum TSH (r=0.356, p<0.001), suggesting that poorer glycemic control was associated with higher TSH levels [Table: 5].

**Table 5: Correlation between HbA1c and serum TSH**

| Variables | N | Pearson correlation (r) | p-value |
|---|---|---|---|
| HbA1c vs TSH | 100 | 0.356 | <0.001 |

## Discussion

A significant association was observed between BMI and thyroid dysfunction (p=0.001). Obesity was more frequent in subclinical hypothyroidism (62.5%) and overt hypothyroidism (77.8%) than in euthyroid participants (26.8%), suggesting an important relationship between excess adiposity and hypothyroid states. This may be explained by the bidirectional interaction between thyroid hormones and obesity through alterations in energy expenditure, thermogenesis, insulin resistance, and leptin-mediated hypothalamic–pituitary–thyroid axis activity [8,9].

Poor glycemic control was also significantly associated with thyroid dysfunction. HbA1c ≥7% was observed in 68.8% of patients with subclinical hypothyroidism and 77.8% with overt hypothyroidism, compared with 26.8% of euthyroid patients (p=0.002). Mean HbA1c was correspondingly higher in subclinical (8.72±1.61%) and overt hypothyroidism (8.32±1.41%) than in euthyroid subjects (7.27±1.17%). Similar associations between thyroid dysfunction and impaired glycemic control have been reported in previous studies and meta-analyses [10,11]. HbA1c showed a significant positive correlation with serum TSH (r=0.356, p<0.001), indicating that worsening glycemic status was associated with higher TSH levels.

Comparable correlations have been reported previously, while Chen et al. demonstrated a nonlinear relationship between thyroid hormone parameters and HbA1c in patients with T2DM [12,13]. Thyroid hormones influence hepatic glucose production, insulin secretion, glucose utilization, and insulin sensitivity, whereas hyperglycemia and insulin resistance can themselves alter thyroid hormone metabolism.

A meta-analysis by Rong et al. further reported that higher TSH and lower FT3 and FT4 levels were associated with increased T2DM risk [14]. Nevertheless, prospective individual-participant data have not consistently demonstrated that subclinical thyroid dysfunction independently predicts incident diabetes, suggesting that these associations may partly reflect shared metabolic pathways rather than direct causality. Subclinical hypothyroidism was the predominant thyroid abnormality in the present study, consistent with previous studies showing hypothyroidism, particularly its subclinical form, as the most frequent thyroid disorder among patients with T2DM [14, 15]. Overall, these findings highlight a close interrelationship between obesity, poor glycemic control, and hypothyroid states and

support consideration of thyroid assessment in newly diagnosed T2DM patients, particularly those with higher BMI or inadequate glycemic control.

## Conclusion

Thyroid dysfunction in newly diagnosed T2DM was significantly associated with both higher BMI and poor glycemic control. Obesity and elevated HbA1c were particularly frequent among patients with subclinical and overt hypothyroidism, while HbA1c showed a significant positive correlation with serum TSH. These findings suggest a close metabolic relationship between adiposity, glycemic status, and thyroid function. Assessment of thyroid function may therefore be particularly useful in newly diagnosed T2DM patients with obesity or inadequate glycemic control, facilitating early identification and appropriate management of coexisting thyroid dysfunction.

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