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Cross-sectional study of thyroid abnormalities in type 2 diabetic mellitus patients for Datia region, India

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Abstract:
Thyroid dysfunction frequently co-exists with Type 2 Diabetes Mellitus, but its relationship with glycemic control and patient characteristics requires further evaluation. Therefore, it is of interest to assess the thyroid function in 250 patients with Type 2 Diabetes Mellitus over 18 months using fasting and postprandial blood glucose, glycated hemoglobin and thyroid hormone measurements. Thyroid dysfunction was identified in 29.2% of patients and was significantly more common in females (37.8% versus 16.7%; p = 0.0005), with subclinical hypothyroidism being the predominant abnormality and a significant association observed between thyroid dysfunction and poor glycemic control (p = 0.0136). Glycated hemoglobin showed a weak but significant positive correlation with thyroid-stimulating hormone (r = 0.1875; p = 0.0029), indicating higher thyroid dysfunction prevalence among poorly controlled diabetic patients. Thus, data support routine thyroid screening, particularly for subclinical hypothyroidism, to improve metabolic management and reduce long term complications in individuals with Type 2 Diabetes Mellitus.

Keywords: Type 2 diabetes mellitus (T2DM), thyroid dysfunction, glycated hemoglobin (HbA1c), thyroid-stimulating hormone (TSH), glycemic control

Background:
Diabetes mellitus has emerged as one of the most significant public health challenges of the 21st century, with type 2 diabetes mellitus (T2DM) accounting for nearly 90–95% of all diabetes cases worldwide. The global burden of T2DM has increased rapidly due to urbanization, sedentary lifestyle, obesity, population aging and dietary transitions, particularly in developing countries such as India **[1].** T2DM is a complex metabolic disorder characterized by chronic hyperglycemia resulting from insulin resistance and relative insulin deficiency, leading to long-term damage, dysfunction and failure of various organs **[2].** The thyroid gland plays a crucial role in regulating metabolism, energy expenditure, lipid and carbohydrate metabolism and insulin sensitivity **[3].** Disorders of thyroid function, particularly hypothyroidism and hyperthyroidism, can significantly alter glucose metabolism and exacerbate metabolic derangements in patients with diabetes. Thyroid dysfunction has been as one of the most common endocrine disorders associated with diabetes mellitus, second only to diabetes itself **[4].** Recent evidence also suggests that thyroid dysfunction may be associated with diabetic complications, with hypothyroidism reported to be associated with higher odds of retinopathy, nephropathy, neuropathy and peripheral arterial disease in patients with T2DM **[5].** Hyperglycemia has been shown to reduce thyrotropin-releasing hormone (TRH) secretion and alter thyroid-stimulating hormone (TSH) response, leading to subtle abnormalities in thyroid function tests even in the absence of overt thyroid disease **[6].** Conversely, hypothyroidism can worsen insulin resistance; promote weight gain, dyslipidemia and hypertension, thereby increasing cardiovascular risk in diabetic patients **[7].** Hyperthyroidism, on the other hand, increases hepatic glucose output, enhances intestinal glucose absorption and accelerates insulin degradation, resulting in poor glycemic control **[8].** Glycated hemoglobin (HbA1c) is widely used as a marker of long-term glycemic control and is an essential tool in the management of T2DM. Emerging evidence suggests a significant association between thyroid dysfunction and HbA1c levels, independent of plasma glucose concentration **[9].** Therefore, it is of interest to evaluate thyroid abnormalities in patients with type 2 diabetes mellitus in the Datia region.

Materials and Methods:
The observational, hospital-based, cross-sectional study was conducted in the Department of General Medicine, Government Medical College and associated District Hospital, Datia, Madhya Pradesh, India, for a period of 18 months after obtaining approval from the Institutional Ethics Committee. 250 participants fulfilling the inclusion criteria were selected for the study by using a purposive sampling technique.

Inclusion criteria:
Adult patients aged 18 years and above, of either gender, with a confirmed diagnosis of type 2 diabetes mellitus based on American Diabetes Association (ADA) criteria, newly diagnosed and previously known cases of type 2 diabetes mellitus, who were willing to participate in the study and provided written informed consent.

Exclusion criteria:
Patients with known thyroid disorders diagnosed prior to the study, already receiving thyroid hormone replacement therapy or antithyroid medications, with type 1 diabetes mellitus, gestational diabetes mellitus, or secondary diabetes, pregnant or lactating women, having severe systemic illness such as chronic liver disease, chronic kidney disease, malignancy, or acute critical illness and patients unwilling to give informed consent. After obtaining informed written consent, eligible participants were enrolled in the study. A detailed clinical history was obtained, including duration of diabetes, treatment details and associated symptoms suggestive of thyroid dysfunction, followed by a thorough general and systemic examination. Blood samples were collected under aseptic precautions after an overnight fast for estimation of fasting blood glucose, HbA1c and thyroid function tests, while postprandial blood glucose samples were collected as per standard protocol. All investigations were carried out in the central laboratory of the institution using standardized methods. The parameters studied included demographic variables such as age and gender; clinical variables such as duration of diabetes, treatment modality (oral hypoglycaemic agents and/or insulin) and presence of

comorbidities; and laboratory parameters including fasting blood glucose, postprandial blood glucose, glycated hemoglobin (HbA1c), serum thyroid-stimulating hormone (TSH), free triiodothyronine (FT3) and free thyroxine (FT4). Thyroid function status was classified based on standard reference ranges. Data were collected using a predesigned proforma. The data collected were entered into a Microsoft Excel spreadsheet and analyzed using the SPSS version 26.0. Continuous variables were expressed as mean and standard deviation, while categorical variables were expressed as frequencies and percentages. The association between thyroid dysfunction and various clinical parameters was assessed using the chi-square test for categorical variables and the Student's t-test or ANOVA for continuous variables, wherever applicable. A p-value of less than 0.05 was considered statistically significant.

Results:

The age- and sex-wise distribution of the study population demonstrates that the highest proportion of patients with Type 2 diabetes mellitus was observed in the 51–60 years age group (30.4%), closely followed by the 41–50 years age group (29.2%). The lowest representation was noted in the 18–20 years and >80 years age groups (2.0% each). Overall, there was a clear female predominance, with females accounting for 59.2% of the study population compared to 40.8% males. This female preponderance was consistent across most age groups, particularly within the 41–60 years range, indicating a higher burden of disease among middle-aged women in the study cohort **(Table 1). Table 2** describes the distribution of diabetic cases according to their HbA1c levels, where the majority of patients (62) had HbA1c in the range of 8–9, followed by 9–10 (55) and 7–8 (52). Only 38 patients had good glycaemic control with HbA1c <7, indicating that the majority of the study population had suboptimal glycaemic control. **Table 3** depicts the prevalence of thyroid dysfunction among the 250 Types 2 DM patients, wherein 73 patients (29.2%) had an abnormal thyroid profile and 177 patients (70.8%) had a normal thyroid profile. The overall prevalence of thyroid dysfunction in the present study was 29.2%. **Table 4** illustrates the distribution of types of thyroid disorders according to gender, where subclinical hypothyroidism was the most common type of thyroid disorder in both males (9) and females (28). Female patients had a higher frequency of all subtypes of thyroid disorders compared to males, with hypothyroid disorders predominating in both genders. **Table 5** describes the distribution of types of thyroid disorders according to HbA1c levels, where subclinical hypothyroidism was the most common disorder across all HbA1c categories, with the highest number (11) in the HbA1c 9–10 group. Primary hypothyroidism was most frequent in patients with HbA1c 8–9, 9–10 and >10 (5 cases each), suggesting a trend of increasing hypothyroid disorders with worsening glycaemic control. **Table 6** shows the association of gender with thyroid dysfunction, where thyroid dysfunction was significantly more prevalent in females (56, 37.8%) compared to males (17, 16.7%). The association between gender and thyroid dysfunction was found to be statistically significant (χ^2 = 12.0876, df = 1, p = 0.0005) using the Chi-square test with Yates continuity correction. **Table 7** illustrates the association of HbA1c level with thyroid dysfunction, where the highest prevalence of thyroid dysfunction was observed in patients with HbA1c 9–10 (25, 45.5%), followed by HbA1c >10 (15, 34.9%). The association between HbA1c level and thyroid dysfunction was found to be statistically significant (χ^2 = 12.5692, df = 4, p = 0.0136) using the Chi-square test. **Table 8** shows the correlation between HbA1c and TSH levels in the study population using Pearson correlation analysis. A weak but statistically significant positive correlation was observed between HbA1c and TSH levels (r = 0.1875, p = 0.0029), indicating that increasing HbA1c levels were associated with higher TSH values among the Type 2 DM patients.

Table 1: Age- and sex-wise distribution of patients with type 2 diabetes mellitus (n = 250)

Age Group (years)	Male (n)	Female (n)	Total (n)
18–20	1	4	5
21–30	4	7	11
31–40	15	20	35
41–50	35	38	73
51–60	30	46	76
61–70	10	23	33
71–80	4	8	12
>80	3	2	5
Total	**102**	**148**	**250**

Table 2: Distribution of diabetic cases according to HbA1c level

HbA1C Level	Number of Cases
<7	38
7-8	52
8-9	62
9-10	55
>10	43
Total	**250**

Table 3: Diabetic cases with abnormal thyroid function

Thyroid Dysfunction	Number of Cases	Percentage
With normal thyroid profile	177	70.8%
With abnormal thyroid profile	73	29.2%
Total	**250**	**100.0%**

Table 4: Type of Thyroid disorders according to gender in type 2 DM

Gender	Subclinical Hypothyroidism	Primary Hypothyroidism	Subclinical Hyperthyroidism	Primary Hyperthyroidism
Male	9	4	2	2
Female	28	12	10	6

Table 5: Type of Thyroid disorders according to HbA1C in type 2 DM

HbA1C Level	Subclinical Hypothyroidism	Primary Hypothyroidism	Subclinical Hyperthyroidism	Primary Hyperthyroidism
<7	6	0	3	0
7-8	5	1	2	1
8-9	8	5	1	1

9-10	11	5	5	4
>10	7	5	1	2

Table 6: Association of gender with thyroid dysfunction

Gender	Normal Thyroid n (%)	Abnormal Thyroid n (%)	Total	χ^2	df	p-value
Male	85 (83.3%)	17 (16.7%)	102	**12.0876**	**1**	**0.0005**
Female	92 (62.2%)	56 (37.8%)	148			
Total	**177 (70.8%)**	**73 (29.2%)**	**250**			

Table 7: Association of HbA1c level with thyroid dysfunction

HbA1C Level	Normal Thyroid n (%)	Abnormal Thyroid n (%)	Total	χ^2	df	p-value
<7	29 (76.3%)	9 (23.7%)	38	**12.5692**	**4**	**0.0136**
7-8	43 (82.7%)	9 (17.3%)	52			
8-9	47 (75.8%)	15 (24.2%)	62			
9-10	30 (54.5%)	25 (45.5%)	55			
>10	28 (65.1%)	15 (34.9%)	43			
Total	**177 (70.8%)**	**73 (29.2%)**	**250**			

Table 8: Correlation between HbA1c and TSH Levels

Correlation	r-value	p-value	Test Used
HbA1c vs TSH	**0.1875**	**0.0029**	Pearson Correlation

Discussion:

Diabetes mellitus and thyroid disorders are among the most common endocrine diseases worldwide and both conditions can significantly influence each other through complex metabolic and hormonal interactions. Thyroid hormones play an important role in regulating carbohydrate metabolism, insulin sensitivity and lipid metabolism, while chronic hyperglycemia may alter thyroid hormone regulation and hypothalamic–pituitary–thyroid axis activity. Therefore, the coexistence of these two endocrine disorders can complicate metabolic control and increase the risk of cardiovascular and systemic complications. The present study was conducted with the aim of evaluating the prevalence and pattern of thyroid abnormalities among patients with Type 2 Diabetes Mellitus in the Datia region and assessing their association with glycemic control and demographic factors such as age and gender. In the present study, the majority of patients were concentrated in the 51–60 years age group (76 cases), followed closely by the 41–50 years group (73 cases), showing that the burden of type 2 diabetes mellitus was highest in the middle-aged and early elderly population, while only 5 patients each were observed in the 18–20 years and >80 years age groups, indicating that type 2 diabetes was relatively less frequent at the extremes of age in this cohort. This age pattern supports the known epidemiological tendency of T2DM to rise with advancing age, likely due to progressive insulin resistance, declining β-cell reserve and cumulative lifestyle-related risk factors, with comparable observations noted by Sharma *et al.* **[10],** Singh *et al.* **[11]** and El-Tantawy *et al.* **[12],** all of whom emphasized the predominance of middle-aged groups and the increased likelihood of associated thyroid dysfunction in older diabetic individuals. The present study also showed a clear female predominance, with 148 females (59.2%) and 102 males (40.8%), giving a male-to-female ratio of approximately 1:1.45, suggesting that women formed the larger proportion of patients with type 2 diabetes mellitus, which is particularly relevant given their increased susceptibility to thyroid abnormalities. Similar female predominance was reported by Jani *et al.* **[13],** Singh *et al.* **[11],** who also observed a higher burden of thyroid dysfunction among female diabetic patients, thereby indicating that women with T2DM may require closer endocrine surveillance for occult thyroid dysfunction. In the present study, glycaemic control was suboptimal in the majority of cases, with only 38 patients having HbA1c <7, while 52 were in the 7–8 range, 62 in the 8–9 range, 55 in the 9–10 range and 43 had HbA1c >10, indicating that most patients had HbA1c values above the ideal glycaemic target and that poor diabetic control was common in this cohort. These findings are clinically important because worsening glycaemic control may influence thyroid hormone metabolism and increase the probability of thyroid dysfunction. Comparable findings have been reported by Bhattacharya *et al.* **[14],** who observed a higher frequency of thyroid dysfunction in patients with HbA1c ≥8.7% and by Panda *et al.* **[15],** who showed thyroid dysfunction in 26.92% of patients with HbA1c >8% compared to 8.33% in those with better control. The present study found that 73 out of 250 patients (29.2%) had an abnormal thyroid profile, whereas 177 (70.8%) were euthyroid, indicating that nearly one-third of T2DM patients had thyroid dysfunction. This prevalence is comparable to findings by Aljabri **[16]** (27%) but higher than those reported by Al-Sumry *et al.* **[17]** (12.6%) and Biondi *et al.* **[18]** (15.21%). On the other hand, higher prevalences were documented by Zafar *et al.* **[19]** (47.6%), while El-Tantawy *et al.* **[12]** reported a lower prevalence (6.6%) in recently diagnosed diabetics. These variations likely reflect differences in study populations, duration of diabetes and diagnostic criteria. Subclinical hypothyroidism was the most common thyroid abnormality in both sexes, affecting 9 males and 28 females, followed by primary hypothyroidism (4 males, 12 females), whereas hyperthyroid disorders were less frequent, with subclinical hyperthyroidism (2 males, 10 females) and primary hyperthyroidism (2 males, 6 females). Shekhar likewise identified subclinical hypothyroidism as the predominant thyroid abnormality and reported a higher prevalence of thyroid dysfunction among female patients with T2DM **[21].** Consistent with these observations, Jamatia *et al.* reported thyroid dysfunction in 23.6% of patients with T2DM, with subclinical hypothyroidism accounting for the majority of thyroid abnormalities and greater anti-TPO positivity among females **[22].** Overall, there was a clear female predominance and dominance of hypothyroid states. These findings are in

agreement with Biondi *et al.* **[18]** and Dave *et al.* **[20]** all of whom identified subclinical hypothyroidism as the most frequent abnormality. Similarly, Asuti *et al.* reported subclinical hypothyroidism as the most frequent thyroid abnormality among patients with T2DM and observed a greater occurrence of thyroid dysfunction among those with poorer metabolic control **[23].** Although Aljabri **[16]** reported primary hypothyroidism as the most common form, subclinical hypothyroidism remained a significant component, supporting the predominance of hypothyroid disorders in T2DM. With respect to HbA1c categories, subclinical hypothyroidism remained the most frequent abnormality across all groups, particularly in the 9–10 HbA1c range, while primary hypothyroidism was more common in poorly controlled groups and hyperthyroid states were comparatively fewer. This pattern indicates that thyroid dysfunction increases with worsening glycaemic control. Similar observations were made by Al-Sumry *et al.* **[17],** who found subclinical hypothyroidism more common among poorly controlled diabetics and by Aljabri **[16],** who reported significantly higher HbA1c levels in patients with hypothyroidism. Thyroid dysfunction was significantly more common among females, with 17 of 102 males (16.7%) and 56 of 148 females (37.8%) affected (χ^2 = 12.0876, p = 0.0005), confirming a strong association between female gender and thyroid abnormalities. This finding is consistent with Al-Sumry *et al.* **[17],** who reported that 86% of thyroid dysfunction cases occurred in females and Dave *et al.* **[20],** who observed a similar statistically significant female predominance. Biondi *et al.* **[18]** and Sharma *et al.* **[10]** also reported a higher prevalence among females. However, Aljabri **[16]** and Singh *et al.* **[11]** noted female predominance without statistical significance, indicating some variability across studies. A statistically significant association was observed between HbA1c levels and thyroid dysfunction (χ^2 = 12.5692, p = 0.0136), with the highest proportion seen in the 9–10 HbA1c group. These findings are supported by Panda *et al.* **[15]**, who showed a significantly higher prevalence of thyroid dysfunction in patients with HbA1c >8% and by Thankappan **[14],** who reported similar trends at higher HbA1c levels. Aljabri **[16]** also found significantly elevated HbA1c in hypothyroid patients, while Sharma *et al.* **[10]** identified poor glycaemic control as a key predictor. In contrast, Dave *et al.* **[20]** did not find a significant association, highlighting inter-study variability. A weak but statistically significant positive correlation between HbA1c and TSH levels (r = 0.1875, p = 0.0029) was observed, indicating that rising HbA1c is associated with increasing TSH levels and a shift toward hypothyroid status. Similar associations have been reported by Aljabri **[16],** who found higher HbA1c levels in hypothyroid patients and by Sharma *et al.* **[10],** who demonstrated a higher prevalence of thyroid dysfunction in poorly controlled diabetics. However, Dave *et al.* **[20]** did not observe a significant correlation, suggesting that while the association exists, its strength may vary depending on study design and population characteristics. The present study has several strengths, including a relatively adequate sample size of 250 patients with Type 2 Diabetes Mellitus and a cross-sectional design that enabled systematic assessment of the prevalence and pattern of thyroid dysfunction. It evaluated not only overall prevalence (29.2%) but also associations with gender, glycaemic control and TSH correlation, providing a comprehensive understanding of the diabetes–thyroid relationship. The use of HbA1c-based categorization offered an objective measure of glycaemic status and demonstrated its significant association with thyroid dysfunction, while identifying subclinical hypothyroidism as the most common and clinically relevant abnormality. The application of appropriate statistical tests, including Chi-square and Pearson correlation, adds scientific rigor and enhances the reliability and clinical applicability of the findings. However, the study has limitations, including its cross-sectional design, which precludes causal inference and its single-center setting, which may limit generalizability. It also relied primarily on thyroid function tests without detailed assessment of thyroid autoimmunity, imaging, or long-term follow-up and did not extensively account for confounding factors such as duration of diabetes, BMI, medications, comorbidities, iodine status and lipid profile. Additionally, smaller subgroup sizes and the lack of longitudinal data limit interpretation of outcomes and the impact of thyroid dysfunction on diabetic control; therefore, these factors should be considered when interpreting the results.

Conclusion:

Thyroid dysfunction was present in 29.2% of patients with Type 2 Diabetes Mellitus, with subclinical hypothyroidism being the most common abnormality and a significantly higher prevalence among females. Poor glycemic control was significantly associated with thyroid dysfunction and glycated hemoglobin showed a positive correlation with thyroid-stimulating hormone levels, indicating worsening thyroid abnormalities with increasing hyperglycemia. Thus, data support routine thyroid function screening, particularly in female patients and those with uncontrolled diabetes, to facilitate early intervention and improve long-term metabolic outcomes.

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