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Impact of Thyroid Dysregulation on Glycemic Control in Type 2 Diabetes Mellitus: A Comparative Investigation

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ABSTRACT

Background: Diabetes mellitus (DM) and thyroid dysfunction (TD) are among the most prevalent endocrine disorders globally, with a complex bidirectional relationship. Thyroid hormones play a pivotal role in regulating carbohydrate metabolism and pancreatic function. This study investigates the prevalence and patterns of thyroid dysfunction in patients with type 2 diabetes mellitus (T2DM) compared to a non-diabetic control group. **Methods:** A descriptive and comparative study was conducted at Al-Sehat Hospital, Timergara, Lower Dir, involving 330 participants divided into two groups: non-diabetic controls (n=165) and confirmed T2DM patients (n=165). Blood samples were analyzed for thyroid function tests (TFTs) and glycated hemoglobin (HbA1c) using automated analyzers. Data were analyzed using SPSS version 22, with results expressed as frequencies, percentages, and descriptive statistics. **Results:** Thyroid dysfunction was observed in 20% of T2DM patients, significantly higher than the 8.43% in the control group. Among diabetic patients, hyperthyroidism (14.54%) was more prevalent than hypothyroidism (5.46%). Females were disproportionately affected, constituting 84.84% of diabetic cases with T2DM. Age was a significant factor, with higher T2DM prevalence in individuals over 40 years. Mean HbA1c in diabetic patients was 9.84±3.385, reflecting poor glycemic control. **Conclusion:** The study highlights a significantly higher prevalence of thyroid dysfunction in T2DM patients compared to non-diabetic individuals, with hyperthyroidism being the most common abnormality. Routine screening for thyroid dysfunction, particularly in high-risk groups, is essential for timely diagnosis and management to mitigate complications.

INTRODUCTION

Diabetes mellitus (DM) and thyroid dysfunction are among the most frequently encountered endocrine disorders globally, and their interrelationship has been extensively documented. Thyroid hormones, specifically triiodothyronine (T3) and thyroxine (T4), are pivotal in regulating carbohydrate metabolism and pancreatic function. Hypothyroidism has been shown to increase susceptibility to hypoglycemia by reducing insulin requirements, while hyperthyroidism impairs glycemic control, complicating the clinical management of diabetes mellitus [1, 2].

Thyroid hormones significantly influence glucose homeostasis through various mechanisms, including altering circulating insulin levels, modifying counter-regulatory hormones, enhancing intestinal glucose absorption, and modulating hepatic glucose production and peripheral glucose uptake. These hormones also stimulate gluconeogenesis and glycogenolysis, which collectively underscore their impact on the metabolic pathways involved in diabetes [3, 4, 5, 6]. A study conducted highlight the role of thyroid function in metabolic syndrome, emphasizing its contribution to dysglycemia [5]. Similarly, another study detailed the intricate thyroid-pancreas axis, elucidating the molecular underpinnings of thyroid hormone-mediated effects on glucose metabolism [6].

The prevalence of thyroid dysfunction is well-recognized in patients with type 1 diabetes due to its autoimmune etiology; however, studies have also reported its significant occurrence in type 2 diabetes mellitus [2, 3, 7]. An investigation was documented a higher frequency of thyroid dysfunction in type 2 diabetic patients compared to the general population, linking this to chronic inflammation and metabolic derangements [7]. Furthermore, a landmark study on thyroid dysfunction prevalence among diabetic patients,

identifying hypothyroidism and subclinical thyroid disorders as common comorbidities [8].

The bidirectional influence of these endocrine disorders necessitates routine evaluation of thyroid function in diabetic patients to facilitate timely diagnosis and management, minimizing the risk of complications. Routine screening becomes particularly crucial in high-risk groups, such as postmenopausal women and elderly individuals with long-standing diabetes, as highlighted by [9].

This study aims to investigate the Frequency and patterns of thyroid dysfunction among patients with type 2 diabetes mellitus and compare them with a non-diabetic general population.

MATERIALS AND METHODS

Study Design

This descriptive and comparative study was designed to assess the prevalence of thyroid dysfunction in patients with type 2 diabetes mellitus (T2DM) and compare it to a non-diabetic control group.

Study Setting and Population

The study was conducted in the Department of Pathology at Al-Sehat Hospital, Timergara, Lower Dir, a tertiary care hospital. The study population consisted of two groups: **Group I** (control group), comprising non-diabetic individuals, and **Group II**, consisting of patients with confirmed T2DM.

Sample Size and Sampling Technique

A total of 330 participants were included, with 165 individuals in each group. The sample size was determined using the WHO sample size calculator. A simple and convenient sampling technique was employed to recruit participants from the hospital's inpatient and outpatient departments.

Ethical Considerations

Ethical approval was obtained from the Department of Pathology, Al-Sehat Hospital, Timergara, Lower Dir. Written informed consent was obtained from all participants, and confidentiality of data was ensured for academic purposes.

Sample Collection and Laboratory Analysis

Blood samples were collected daily in the hospital's phlebotomy area after obtaining informed consent. A total of 330 blood samples were collected, with 165 samples each from the control and diabetic groups.

- **Thyroid Function Tests (TFTs):** Blood samples for TFTs were collected in gel separator tubes containing clot activator. After collection, tubes were gently inverted five times to mix the clot activator, allowed to clot for 30 minutes in an upright position, and centrifuged at 3,000 rpm for 15 minutes to separate the serum. Serum samples were analyzed on the fully automated Cobas e411 Immunoassay Analyzer based on electrochemiluminescence (ECL) technology.
- **Glycated Hemoglobin (HbA1c):** Blood samples for HbA1c were collected in EDTA tubes. The samples were inverted 7–8 times to ensure proper mixing with the anticoagulant. HbA1c levels were measured on the fully automated Architect ci2800 Analyzer using an enzymatic spectrophotometric method.

Classification of Results

- For TFTs: Normal T3, FT4, and TSH values were defined as 1.49–2.6 nmol/L, 10–28 pmol/L, and 1.36–8.8 mIU/L, respectively.
- For HbA1c: According to American Diabetes Association (ADA) guidelines, HbA1c levels of 5.7–6.4% indicated a high risk of diabetes, while levels ≥6.5% were diagnostic for diabetes.

Statistical Analysis

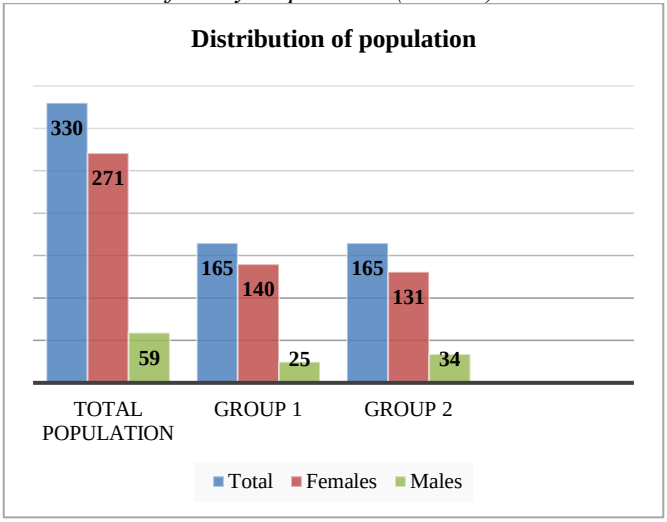
Data were coded, recorded, and analysed using SPSS version 22. Descriptive statistics, including frequencies, means, and standard deviations, were calculated. Results were presented in the form of graphs, tables, and charts.

RESULTS

A total of the 330 patients both national and international were included in the study. Patients were divided into two groups. Out of 165 patients in Group 1 non-diabetic (control), 140 (84.84%) were females while 25 (15.15%) were male. Likewise, out of 165 patients of the diabetic type 2 group 131 (79.39%) were female and 34 (20.60%) were males (Fig. 1).

Figure 1

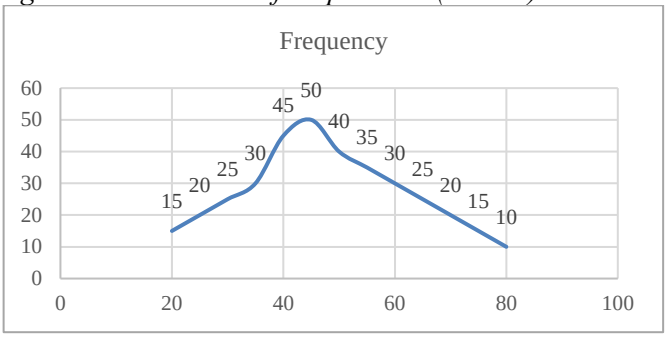
Distribution of Study Population (N=330)



The graph shows the age distribution of 330 patients, with a mean age of 45.79 years and a standard deviation of 13.193. Most ages cluster around the mean, with variability reflected in the spread. Mean age of the patients was 45.79 with a standard deviation of 13.193 (Fig. 2).

Figure 2

Age wise distribution of all patients. (N=330)



The thyroid profile analysis of the group I (control group) showed the prevalence rate of thyroid dysfunction as 8.43% (n=14) and euthyroid as 91.57% (n=151) (Table 1).

Table 1

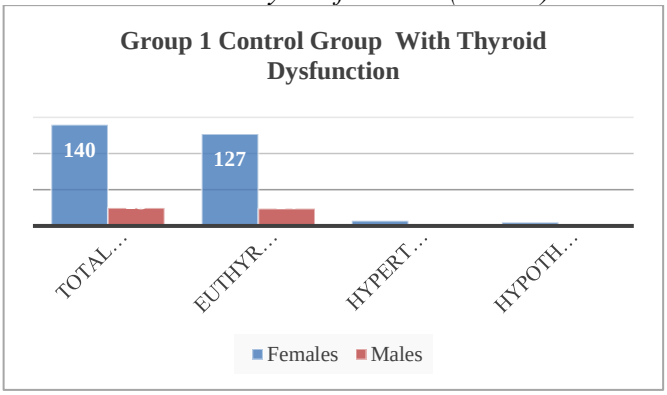
Demographic representation of Control and Diabetic Group (N=330).

Patients	Age (Mean±SD)	Thyroid status	Total	Male	Female
Control Group (n=165)	41.54±13.97	Euthyroid	151	24	127
		Thyroid disorder	14	1	13
Diabetic Group (n=165)	50.120±10.94	DM without Thyroid disorder	132	29	103
		DM with Thyroid disorder	33	5	28

The control group with thyroid dysfunction consisted of 92.25 % (n=13) females and 8.75 % (n=1) males. Out of total 14 (87.5 % females and 12.5% males), 57.14 % (n=8) were having hyperthyroidism. The rest of the 42.85% (all females) patients were suffering from hypothyroidism. (Fig. 3).

Figure 3

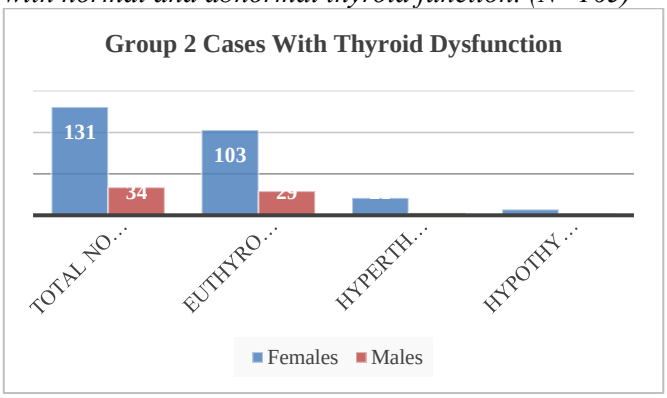
Bar chart showing distribution of control group with normal & abnormal thyroid function. (N=165)



Among cases, analysis of thyroid profile showed that TD in type 2 diabetic patients was 20% (n=33) and 80% (n=132) were Euthyroid. The diabetic patients with TD consisted of 84.84% (n=28) of females and 15.15% (n=5) were males. Out of a total of 33 abnormal cases in diabetic patients, 72.72% (n=24) were having hyperthyroidism with 87.5% (n=21) females and 12.5% (n=3) males. Remaining of 27.27% (n=9) cases out of 33 were having hypothyroidism with 77.77% (n=7) females and 22.22% (n=2) males (Fig. 3.4).

Figure 4

Bar chart showing representation of diabetic patient with normal and abnormal thyroid function. (N=165)

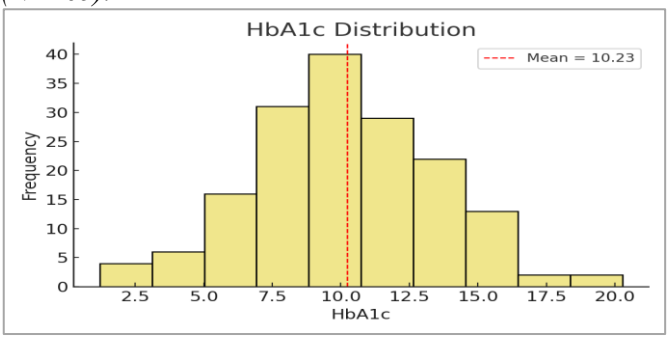


HbA1c levels in Group 2 cases

The following histogram shows the distribution of HbA1c levels in Group 2 cases. The mean HbA1c value is 9.84 with a standard deviation of 3.385, as shown in the graph below. (Fig. 3.5).

Figure 5

Distribution of HbA1c in Diabetic Group-Cases (N=165).



DISCUSSION

Diabetes mellitus (DM) and thyroid dysfunction (TD) are two closely related endocrine disorders, with thyroid hormones playing a significant role in carbohydrate metabolism, pancreatic function, and glucose homeostasis. Hypothyroidism increases susceptibility to hypoglycemia, whereas hyperthyroidism impairs glycemic control, complicating the management of diabetes mellitus [10, 11]. Thyroid hormones influence glucose homeostasis by modulating insulin secretion, intestinal absorption, hepatic glucose production, and peripheral glucose uptake, as well as stimulating gluconeogenesis and glycogenolysis [12].

In the present study, the prevalence of thyroid dysfunction among Type 2 DM patients was 20%, significantly higher than the 8.43% observed in the non-diabetic control group. Among diabetic patients with TD, hyperthyroidism was more prevalent (14.54%)

compared to hypothyroidism (5.46%). These findings are consistent with previous studies. For instance, Radaideh et al. [10] reported a 12.5% prevalence of thyroid dysfunction in Type 2 DM patients, while Makandar et al. [12] observed a higher prevalence rate of 32%. A study by Kulkarni et al. [11] reported a prevalence of 17.71%, further underscoring the variability in TD rates across different populations.

The gender distribution in the present study highlighted a higher predisposition of females to thyroid dysfunction in both diabetic and non-diabetic groups. Among diabetic patients, 16.96% of females and 3.04% of males were affected. Similarly, in the control group, 92.25% of patients with TD were females. These results align with findings from Radaideh et al. [10] and Papazafiropoulou et al. [13], who reported a higher prevalence of TD in females than males, reflecting the potential influence of hormonal differences and genetic predispositions.

Age emerged as a significant factor, with individuals over 40 years exhibiting a higher prevalence of thyroid dysfunction. This observation supports earlier findings by Radaideh et al. [10], who demonstrated that thyroid dysfunction in diabetic patients is more common among those above 40 years. The age-related increase in thyroid dysfunction could be attributed to the cumulative effects of chronic hyperglycemia, systemic inflammation, and immune dysregulation on thyroid function over time.

The association between diabetes and thyroid dysfunction has been well established, with studies indicating that thyroid disorders are more common in Type 1 DM due to its autoimmune origin [13]. However, similar occurrences of TD in Type 2 DM have been widely reported [12, 14]. The interplay between these two endocrine disorders underscores the need for routine screening of thyroid function in diabetic patients to prevent complications and optimize glycemic control [12, 14].

The findings of the present study emphasize the importance of regular thyroid screening in Type 2 DM patients, especially among females and individuals over 40 years of age. Early detection and management of thyroid dysfunction can help mitigate the risks of poor glycemic control, cardiovascular complications, and other metabolic derangements.

CONCLUSIONS

This study demonstrates a significantly higher prevalence of thyroid dysfunction among patients with Type 2 diabetes mellitus (20%) compared to the non-diabetic population (8.43%). Hyperthyroidism was the predominant thyroid disorder observed in diabetic patients, followed by hypothyroidism. Females were found to be more susceptible to thyroid dysfunction than males, and individuals over 40 years of age exhibited a higher risk of developing thyroid abnormalities.

The findings underscore the established association between thyroid dysfunction and Type 2 diabetes mellitus. Given the impact of thyroid abnormalities on glycemic control and the potential for complications, routine screening and regular monitoring of thyroid profiles in diabetic patients are strongly recommended. This approach can facilitate early diagnosis and timely management, thereby improving clinical outcomes and minimizing the risk of diabetes-related complications.

Further multicenter and longitudinal studies are warranted to confirm these findings and explore the underlying mechanisms of the relationship between diabetes and thyroid dysfunction. Such investigations could also help in devising targeted interventions to address this dual burden of endocrine disorders.

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