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Evaluation of Thyroid Dysfunction among Type 2 Diabetic Patients in a Tertiary Care Hospital

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Abstract

Background: *Diabetes mellitus is the commonest endocrine disease and many diabetic patients suffer from thyroid dysfunction (TD) later in their life. Thyroid hormones directly control insulin secretion and insulin clearance. Diabetes also may affect the thyroid function to variable extent first at the level of hypothalamic control of TSH release and second at the peripheral tissue by converting T4 to T3.*

Aims and objectives: *The present study was carried out to determine the prevalence of thyroid dysfunction (TD) among type 2 Diabetes mellitus (T2DM) patients in a tertiary care hospital.*

Methodology: *A cross-sectional hospital-based study was conducted to find out the prevalence of TD among 246 admitted T2DM patients in the medicine ward of Sylhet MAG Osmani Medical College Hospital of Bangladesh in 2022. They were investigated for fasting blood glucose (FBG), glycosylated haemoglobin (HbA1c), two hours post-prandial glucose (2HPPG), free tri-iodothyronine (FT3), free thyroxine (FT4) and thyroid-stimulating hormone (TSH).*

Results: *Prevalence of TD in T2DM was found in 25.6% patients. Gender-specific prevalence found higher in males (28.9%) compared to females (21.6%) (P=0.194). Age-specific prevalence found higher in the age group (41-50 yrs) (30.8%) compared to other age groups (P=0.493). Subjects with poor glycaemic control (HbA1c 7.1-10%) demonstrated higher prevalence (32.5%) (P=0.135). Subjects with long-standing T2DM (10-12 years) had an increased risk for thyroid dysfunction (41.4%) (P=0.122). There is significant correlation between FBG and FT4 (r=-0.212, P<0.001) and also between 2HPPG and FT4 (r=-0.202, P=0.001) which will need further research.*

Conclusion: *The prevalence of TD was quite high (25.6%) among T2DM. We found more males (28.9%) with TD compared to females (21.6%) and especially hypo- thyroidism (19.9%) being more typical than hyperthyroidism (5.7%). Also, a continuous negative correlation of FT4 with FBG and 2HPPG were found. Hence, universal screening and regular monitoring of TD in T2DM patients are recommended.*

Keywords: *Thyroid dysfunction (TD), Type 2 diabetes mellitus (T2DM).*

1. INTRODUCTION

Type 2 diabetes mellitus (T2DM) is the commonest endocrine disorder [1]. The association between T2DM and thyroid dysfunction (TD) was first reported in 1977 [2].

Since then, a number of studies had estimated the prevalence of Thyroid Dysfunction (TD) among type 2 diabetic patients which varied from 2.2 to 17% [3,4] and fewer studies had estimated much higher prevalence of TD among T2DM i.e. 31 % and 46.5% respectively [5,6]. Thyroid dysfunction (TD) is a spectrum of disorders of the thyroid gland, manifests either as hyperthyroidism or hypo- thyroidism, reflected in the circulating levels of thyroid stimulating hormone (TSH) [7] T2DM and thyroid disorders have been shown to influence each other mutually because of intersecting pathology [8] Thyroid hormones cause an increase in the hepatocyte concentration of glucose-6-phosphate, glucose transporter 2 (GLUT2), thereby leading to increased hepatic glucose output and abnormal glucose metabolism, giving rise to the overproduction of lactate entering Cori's cycle and further promote hepatic gluconeogenesis [9] Thyroid hormones also cause an increase in gut glucose absorption and increase lipolysis which also increases hepatic gluconeogenesis. Thus, TD may lead to the development of insulin resistance. In patients with T2DM, the nocturnal TSH peak is blunted or abolished; and the TSH response to TRH, from the hypothalamus, is impaired thus leading to hypothyroidism [10]. Low T3 levels have been observed in uncontrolled DM. This has been ascribed to the impairment in peripheral conversion of tetra-iodothyronine (T4) to tri-iodothyronine (T3) which normalizes with improvement in glycaemic control [11,8]. This is as a result of the hyperglycaemia-induced reversible reduction of the activities and hepatic concentration of thyroxine 5'deiodinase [8]. Higher levels of circulating insulin associated with insulin resistance has been shown to have a proliferative effect on thyroid tissue resulting in larger thyroid size with increased formation of nodules [11,12]. This may lead to thyroid dysfunction (hyperthyroidism) in patients with T2DM. A possible genetic interaction has also been noted between the development of thyroid dysfunction and T2DM. Few genes like protein kinase B, inhibitory G protein, GLUT2 [13], phosphoenol-pyruvate kinase [14] has been identified. Aljabri KS et al., (2019)1 has conducted a cross-sectional study in the diabetes centre at King Fahad Armed Forces Hospital, Jeddah, Saudi Arabia from January 2018 to December 2018 among a total of 2069 subjects with T2DM. Among them, 11.1% were primary hypothyroid, 3% were subclinical hypothyroid, 1.6% were hyperthyroid and 6% were found subclinical hyperthyroid. Another cross-sectional hospital-based study was undertaken to find out the prevalence of thyroid dysfunction in 713 T2DM subjects attending Diabetes Centre, KLES Dr Prabhakar Kore Hospital and Medical Research Centre, KLE University, Belagavi, India from January 2014 to October 2015. Among them 14% had hypothyroidism and 2.2% had hyperthyroidism with a total of 16.2% TD was found [15]. Assessment of thyroid status in T2DM patients may be helpful in identifying cases of clinical and subclinical TD. Moreover, T2DM patients who have TD tend to have poorer glycaemic control, an increased risk of lipid disorders, high blood pressure and atherosclerosis, which may accelerate diabetic vascular complications. A link between TD and microvascular complications and coronary artery diseases has also been reported [16]. Studies also have suggested that T2DM patients with subclinical hypothyroidism are at risk of complications like nephropathy and cardiovascular events [17]. Therefore, this study aims to look at the prevalence of thyroid dysfunction among type 2 diabetic patients, admitted in the medicine ward of Sylhet MAG Osmani Medical College Hospital in Bangladesh. This study aims to evaluate the prevalence and identify the risk factors of thyroid dysfunction (hypothyroidism, subclinical hypothyroidism, hyperthyroidism, and subclinical hyperthyroidism) among patients with type 2 diabetes mellitus.

2. METHODOLOGY & MATERIALS

A cross-sectional hospital-based study has been undertaken in the department of Medicine of Sylhet MAG Osmani Medical College Hospital between May 2022 and October 2022 among 246 admitted T2DM patients who met the inclusion criteria. Sampling was done by convenient purposive sampling. With the prevalence of thyroid dysfunction among T2DM of 16.2%, 15 5.0% significance level and 5% marginal error, sample size has been calculated by using the Cochran's formula. The formula is: $n = \frac{Z^2pq}{d^2}$. Our sample size was 209.

2.1. Inclusion Criteria

- All patients with T2DM, irrespective of BP and glucose control status

- All T2DM, irrespective of treatment (oral hypoglycemic agent/insulin).

2.2. Exclusion Criteria

- Patients with T1DM
- Those with history of neck trauma or surgery.
- Subjects with history of previous exposure of radiation in the neck.
- Patients on drugs like amiodarone, lithium, interferon-alpha, iodides, beta-blockers, carbimazole, propyl- thiouracil, potassium iodide, lugol's iodine.
- Patients with known thyroid disorders.
- Acute illness that affects thyroid hormones status.
- Patients who present with complain of fever, neck pain and viral infection (subacute thyroiditis).
- Pregnant and postpartum women.
- GDM, pancreatitis, steroid induced diabetes would be excluded.
- Patients suffering from hemoglo-binopathies and anemia.

2.3. Ethical Considerations

Ethical approval was obtained from the Ethical Committee of Sylhet MAG Osmani Medical College. Written informed consent was secured from all participants prior to data collection, ensuring confidentiality and adherence to ethical research practices.

2.4. Data Collection

Demographic details (age, sex), anthropometric measurements (height, weight, body mass index [BMI]), and blood pressure readings (both systolic and diastolic) were recorded. Information regarding the duration of diabetes, and family history of diabetes and thyroid disorders was also documented. Venous blood samples (approximately 5 mL) were collected from each patient in the morning following an overnight fast. The samples were used to measure fasting blood glucose (FBG), fasting lipid profile, glycated hemoglobin (HbA1c), free triiodothyronine (FT3), free thyroxine (FT4), and thyroid-stimulating hormone (TSH). An additional 5 mL blood sample was collected to determine two-hour postprandial plasma glucose (2HPPG) and serum creatinine levels. Blood glucose levels were estimated using enzymatic methods, while HbA1c was measured based on the principle of High-Performance Liquid Chromatography (HPLC). Serum FT3, FT4, and TSH concentrations were determined using Chemiluminescence Immunoassay (CLIA) technology. Thyroid dysfunction (TD) was diagnosed when thyroid hormone values fell outside the reference ranges: FT3 (2.3–4.2 pg/mL), FT4 (0.89–1.76 ng/mL), and TSH (0.35–5.55 µIU/mL).

2.5. Statistical Analysis

Data were initially entered into Microsoft Excel and subsequently processed and analyzed using SPSS version 26.0 (Statistical Package for Social Sciences, IBM Corp., Armonk, NY, USA). Quantitative variables were summarized as mean ± standard deviation (SD) and compared using the unpaired t-test. Qualitative variables were presented as frequencies and percentages, with group comparisons conducted using the Chi-square test. Pearson's correlation coefficient was used to assess the relationship between thyroid dysfunction and various clinical parameters in T2DM patients. A p-value of less than 0.05 was considered statistically significant throughout the analysis.

3. RESULT

The overall prevalence of thyroid dysfunction (TD) among patients with type 2 diabetes mellitus (T2DM) was found to be 25.6%. Gender-specific prevalence demonstrated a higher rate in males (28.9%) compared to females (21.6%); however, the difference was not statistically significant (χ^2=1.689, df=1, p=0.194) (Table 1). When stratified by age groups (20–30 years, 31–40 years, 41–50 years, and >50 years), the prevalence of TD was lower among younger patients (20–30 years) and relatively higher in older age groups, particularly among those aged 41–50 years (30.8%). However, no significant association was observed between age and TD (χ^2=2.403, df=3, p=0.493) (Table 2). Duration of diabetes was categorized into four groups (0–4 years, 5–9 years, 10–12 years, and >12 years). The prevalence of TD was lowest in patients with a diabetes duration of 0–4 years (18.3%) and highest in those with 10–12 years of diabetes (41.4%). Despite this trend, the association between TD and diabetes duration was not statistically significant (χ^2=5.795, df=3, p=0.122) (Table 3). Glycemic control, assessed by glycated hemoglobin (HbA1c) levels and categorized into five groups (4.4–5.6%, 5.7–6.4%, 6.5–7.0%, 7.1–10.0%, and >10.0%), showed a notable, though statistically insignificant, relationship with TD. Poorly

controlled patients (HbA1c 7.1–10.0%) exhibited a higher prevalence of TD (32.5%) compared to well-controlled individuals (HbA1c 4.4–5.6%) (25%) (χ^2=7.008, df=4, p=0.135) (Table 4). The types of thyroid dysfunction observed among T2DM patients included hypothyroidism in 19.9% (22.2% of males, 17.1% of females) and hyperthyroidism in 5.7% (6.7% of males, 4.5% of females). The total prevalence of TD was thus confirmed at 25.6%, without a statistically significant difference between sexes (χ^2=1.730, df=2, p=0.421) (Table 5). Detailed classification showed primary hypothyroidism in 7.7%, subclinical hypothyroidism in 12.2%, primary thyrotoxicosis in 0.8%, primary T3-toxicosis in 0.8%, and subclinical thyrotoxicosis in 4.1% of patients, while 74.4% remained euthyroid. The differences among these categories were not statistically significant (χ^2=5.405, df=5, p=0.368) (Table 6). Table 7 demonstrates the correlation between glycemic parameters and thyroid hormone levels.

A significant negative correlation was found between fasting blood glucose (FBG) and FT4 levels (r = -0.212, p < 0.001) as well as between 2-hour postprandial glucose (2HPPG) and FT4 (r = -0.202, p = 0.001). However, the correlation between HbA1c and FT4 was negative but not statistically significant (r = -0.039, p = 0.543). Table 8 presents a comparison of various biochemical parameters between T2DM patients with and without TD. Mean FBG, 2HPPG, serum total cholesterol, HDL, LDL, serum creatinine, and FT3 levels were higher among T2DM patients with TD, while HbA1c, serum triglycerides, and FT4 levels were lower in the TD group.

Although most differences were not statistically significant (p > 0.05), serum TSH was significantly higher in the TD group (7.27±5.25 µIU/mL) compared to the non-TD group (2.31±1.48 µIU/mL) (p < 0.001).

Table 1. *Gender Specific Prevalence of Thyroid Dysfunction in T2DM.*

Gender	T2DM with TD	T2DM without TD	Total	p-value
Male	39 (28.9%)	96 (71.1%)	135	0.194
Female	24 (21.6%)	87 (78.4%)	111	
All	63 (25.6%)	183 (74.4%)	246	

X2: 1.689, DF: 1

Table 2. *Age-Specific Prevalence of Thyroid Dysfunction in T2DM.*

Age (years)	T2DM with TD	T2DM without TD	Total	p-value
20-30	0 (0.0%)	2 (100.0%)	2	0.493
31-40	6 (20.0%)	24 (80.0%)	30	
41-50	24 (30.8%)	54 (69.2%)	78	
>50	33 (24.3%)	103 (75.7%)	136	
All	63 (25.6%)	183 (74.4%)	246	

X2: 2.403, DF: 3

Table 3. *Prevalence of Thyroid dysfunction according to Duration of Diabetes (yrs).*

Duration of Diabetes	T2DM with TD	T2DM without TD	Total	p-value
0-4	13 (18.3%)	58 (81.7%)	71	0.122
5-9	34 (26.2%)	96 (73.8%)	130	
10-12	12 (41.4%)	17 (58.6%)	29	
>12	4 (25%)	12 (75%)	16	
All	63 (25.6%)	183 (74.4%)	246	

X2: 5.795, DF: 3

Table 4. *Prevalence of Thyroid Dysfunction according to to glycemic status (HbA1c%).*

HbA1c%	T2DM with TD	T2DM without TD	Total	p-value
4.4-5.6	1 (25%)	3(75%)	4	0.135
5.7- 6.4	2 (20%)	8(80%)	10	
6.5- 7.0	10 (15.4%)	55 (84.6%)	65	
7.1- 10	40 (32.5%)	83(67.5%)	123	
>10.0	10 (22.7%)	34 (77.3%)	44	
All	63 (25.6%)	183 (74.4%)	246	

X2: 7.008, DF: 4

Table 5. *Prevalence of type of thyroid disorder according to Gender of T2DM.*

Sex	Euthyroidism	Hypothyroidism	Hyperthyroidism	Total	p-value
Male	96 (71.1%)	30 (22.2%)	9 (6.7%)	135	0.421
Female	87 (78.4%)	19 (17.1%)	5 (4.5%)	111	
All	183 (74.4%)	49 (19.9%)	14 (5.7%)	246	

X2: 1.730, DF: 2

Table 6. *Prevalence of type of thyroid dysfunction according to Gender of T2DM.*

Sex	Male	Female	All	p-value
Euthyroidism	96 (71.1%)	87 (78.4%)	183(74.4%)	0.368
Primary hypothyroidism	9 (6.7%)	10 (9.0%)	19 (7.7%)	
Subclinical hypothyroidism	21 (15.6%)	9 (8.1%)	30 (12.2%)	
Primary thyrotoxicosis	1 (0.7%)	1 (0.9%)	2 (0.8%)	
Primary T3 toxicosis	2 (1.5%)	0 (0.0%)	2 (0.8%)	
Subclinical thyrotoxicosis	6 (4.4%)	4 (3.6%)	10 (4.1%)	
Total	135	111	246	

X2: 5.405, DF: 5

Table 7. *Pearson's correlation between Diabetic profiles and Thyroid profiles.*

Relationship between	r-values	p-values	Significance
FBG vs TSH	0.074	0.248	NS
FBG vs FT4	-0.212	<0.001	HS
FBG vs FT3	-0.053	0.408	NS
2HPPG vs TSH	0.009	0.894	NS
2HPPG vs FT4	-0.202	0.001	HS
2HPPG vs FT3	0.030	0.634	NS
HbA1c vs TSH	0.019	0.768	NS
HbA1c vs FT4	-0.039	0.543	NS
HbA1c vs FT3	0.083	0.196	NS

Table 8. *Comparison of various biochemical parameters in T2DM 'with TD' and 'without TD' subjects.*

Parameter	T2DM with TD (N=63)	T2DM without TD (N=183)	t-values	p-values
FBG (mg/dl)	10.61±3.21	10.51±3.54	0.213	0.832
2HPPG (mg/dl)	14.26±4.12	13.71±4.10	0.921	0.358
HbA1c (%)	8.24±1.74	8.44±2.29	-0.631	0.529
S. Creatinine (mg/dl)	1.19±0.97	1.06±0.38	1.510	0.132
Total Cholesterol (mg/dl)	183.65±47.69	182.99±50.97	0.090	0.929
HDL (mg/dl)	38.33±8.43	37.51±10.91	0.542	0.588
LDL (mg/dl)	116.13±36.52	110.20±39.49	1.046	0.296
Triglycerides (mg/dl)	204.16±127.71	221.95±136.68	-0.906	0.366
TSH (µIU/L)	7.27±5.25	2.31±1.48	11.538	<0.001
FT4 (ng/ml)	0.895±0.63	1.08±0.76	-1.747	0.082
FT3 (pg/ml)	2.60±1.21	2.598±0.78	0.050	0.960

4. Discussion

This study was conducted to evaluate the thyroid status and to understand the asso-ciation between thyroid disorders and diabetes mellitus in T2DM patients that have been admitted at the Medicine ward of Sylhet MAG Osmani Medical College Hospital (SOMCH), Sylhet, Bangladesh during 2022. It included total 246 T2DM patients who were admitted in the Medicine ward of SOMCH. The prevalence of thyroid dysfunction among T2DM patients was found 25.6% in our study. Among them, 74.4% were euthyroid. We have found 19.9% were hypothyroid (22.2% in males and 17.1% of females) and 5.7% were hyperthyroid (6.7% in males and 4.5% of females). (X2=1.730, DF=2, P-value=0.421) We found among the hypothyroid, 7.7% were primary hypothyroid (6.6% male, 9% female), 12.2% were subclinical hypo- thyroidism (15.6% male, 8.1% female).

Our observations are in consistence with the previous similar studies performed in Bangladesh and other countries, though we have found quite high prevalence. The Wickham study (UK) in 1977 reported 6.6% prevalence of thyroid dysfunction in T2DM patients2 at first. The NHANES III study documented the prevalence of 5.9% in T2DM patients [18]. A study in Jordan by Radaideh et al., found the prevalence of TD to be 12.5% [19]. In another

study by Papazafiropoulouet et al. in Greece, prevalence was shown to be 12.3% [20]. Higher prevalence of 29.7% and 32.4% documented in Nigeria by Ghazali SM et al.7 and in Spain by Diez et al. [21] respectively, like our study. Studies were done in India by Vikhe et al. [22] in Pune and Demitrost et al. [23] in Manipur showed a higher prevalence of 30% and 31.2% respectively. In the present study, we found that the prevalence of TD increased with advancing age. A possible explanation for this would be that older patients might have had undetected diabetes for a longer time. Also, they are more prone to develop insulin resistance and decline in beta cell function [24]. In our study, prevalence found to be increased in poor glycaemic controlled diabetic patients. A study in India by MV Jali et al., 2017 showed that prevalence of TD in T2DM was found in 16.2% and found higher in females (25%) compared to males (10.1%) (P<0.001) [15]. In our study, that prevalence was higher in male (28.9%) compared to female (21.6%). Observations made by us, were not consistent with the observations made by Demitrost et al. [23] and Vikhe et al. [22] in gender specific prevalence of TD. Vamshidhar IS and Rani SS et al., 2020 conducted a study at Telangana, India among 50 T2DM patients and found 16% thyroid dysfunction with 10% male and 6% female dysfunction [25]. They found more male TD like us, so which needs further research for confirmation of female sex as a risk factor. Age-specific prevalence found higher in the age group 41-50 yrs (30.8%).

We found increased prevalence of TD among the T2DM patients with increased duration of DM, 41.4% in 10-12 yrs duration group. The thyroid hormones are insulin antagonists that also potentiate the action of insulin indirectly. TRH synthesis decreases in diabetes mellitus. These facts could be responsible for the occurrences of low thyroid hormone levels in some diabetics. Thyroid hormones levels may be altered by various medications that diabetic subjects used to take. Insulin significantly induces the production of FT4 and suppresses the generation of FT3 by halting the conversion of T4 to T3 in the liver and reduced TRH production in the diabetics. Insulin influenced glycemic status, which modulates TRH and TSH level. Present study found significant correlation between FBG and FT4 (r=-0.212, P<0.001); and also, between 2HPPG and FT4 (r=-0.202, P=0.001) which will need further research for confirmation. Therefore, the present study was intended to evaluate the association between TD with diabetic process and to assess the hyperglycemic effect by correlating fasting & two hours postprandial serum glucose and thyroid profile parameters. Thyroid function tests are especially recommended in patients with clinical suspicion and/or unexplained changes in diabetic metabolic control or serum cholesterol and weight gain. The treatment of hypothyroidism helps in better control of other associated co-morbidities. The ability to diagnose and treat subclinical hypothyroidism in these patients may greatly enhance the quality of life.

5. Limitations of the Study

- Cross-sectional study design limiting causal inference.
- Small sample size of 246 patients.
- Only hospitalized T2DM patients were included.
- No non-diabetic control group for comparison.
- Medication effects on thyroid function were not evaluated.
- No longitudinal follow-up was conducted.
- Confounding factors like iodine status and autoimmune markers were not assessed.
- Gender-specific physiological differences were not deeply analyzed.
- Single-time laboratory measurements without repeated confirmation.

6. Conclusion And Recommendations

Results of present study have shown that in T2DM, hypothyroidism is frequently observed. Patients who are suffering from T2DM should be screened for thyroid disorder especially hypothyroidism for control of both. Our study concluded the prevalence of TD was high in T2DM patients (25.6%) with males being more affected than females. Incidence is increased with advancing age, with poor glycaemic control and also with increased duration of T2DM. Hypothyroidism (19.9%) was observed to be more common than hyperthyroidism (5.7%). Failure to recognize the presence of abnormal thyroid hormone level in T2DM may be a primary cause of poor management of diabetes.

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