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Hidden Endocrine Burden: Hypothyroidism in Type 2 Diabetic Patients at Kosti Teaching Hospital, Sudan

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Abstract
Diabetes mellitus (DM) is a common endocrine disorder characterized by persistent hyperglycemia and associated with long-term complications affecting various organs, including the eyes, nerves, kidneys, and endocrine glands. Among these, thyroid dysfunction—particularly hypothyroidism—has been under-investigated in diabetic populations, despite evidence suggesting a higher prevalence among type II diabetic patients compared to the general population. This coexistence may complicate glycemic control and diabetes management. This case-control hospital-based study was conducted at Kosti Teaching Hospital in Kosti City, White Nile State, Sudan, between April 1st and June 1st, 2023. The study enrolled 96 participants, including 66 patients with type II diabetes mellitus (cases) and 30 non-diabetic controls, selected randomly. All participants underwent detailed history taking, clinical examination, and laboratory testing for fasting blood glucose and thyroid hormone levels (T3, T4, and TSH). Data were collected using structured forms and analyzed statistically. The prevalence of hypothyroidism among type II diabetic patients was 19.6%. Among cases, the mean serum levels were: T3 = 0.72 ± 0.54 µg/dL, T4 = 4.01 ± 1.76 µg/dL, and TSH = 10.28 ± 6.96 µIU/mL. TSH elevation was observed in 22.7% of patients, low T4 in 19.6%, and low T3 in 16.6%. No significant correlation was found between thyroid hormone levels and age or sex. Approximately one-fifth of type II diabetic patients were found to have hypothyroidism. This hormonal imbalance may impair glycemic control and exacerbate complications. Routine screening for thyroid dysfunction in type II DM patients is recommended to improve clinical outcomes and reduce morbidity.
Keywords. *Diabetes Mellitus, Hypothyroidism, Thyroid Hormones.*

Introduction

Diabetes mellitus (DM) is a major and growing public health concern in Sudan, as in many other developing countries. It is a common endocrine disorder characterized by chronic hyperglycemia, leading to long-term complications that affect multiple organ systems, including the eyes, blood vessels, nerves, kidneys, and endocrine glands [1,2]. Both diabetes mellitus and thyroid disorders are known to be prevalent in Sudan, and evidence suggests that their co-occurrence is not uncommon [3,4].

Thyroid hormones—triiodothyronine (T3) and thyroxine (T4)—function as insulin antagonists and indirectly enhance insulin action. In diabetes, the synthesis of thyrotropin-releasing hormone (TRH) is often diminished, which may contribute to the reduced thyroid hormone levels observed in some diabetic individuals [5,6]. Furthermore, patients with certain clinical features or a family history of thyroid dysfunction may be at increased risk of developing thyroid abnormalities. Indeed, diabetes mellitus itself is recognized as a risk factor for thyroid dysfunction, particularly hypothyroidism [7,8].

Despite this, the prevalence and clinical significance of hypothyroidism among patients with type 2 diabetes mellitus (T2DM) have not received sufficient attention in clinical practice or research. There is a need for updated data, particularly in low-resource settings like Sudan, to clarify the relationship between T2DM and thyroid dysfunction [9].

Endocrine alterations in diabetes extend beyond pancreatic function and include disruptions in the hypothalamic-pituitary-thyroid (HPT) axis. The hypothalamus regulates the secretion of T3 and T4 via TRH and thyroid-stimulating hormone (TSH), the latter being secreted by the anterior pituitary. This axis functions through a negative feedback mechanism, wherein increased levels of T3 and T4 suppress TSH release and vice versa [10]. In diabetes, despite normal peripheral metabolism of TSH, there is often reduced production of T3 and T4 and decreased iodide uptake by the thyroid gland [11]. Additionally, peripheral conversion of T4 to T3 is impaired, and notable structural changes in both the thyroid and pituitary glands may occur, affecting their secretory functions. Iodothyronines—such as T3 and T4—are considered insulin antagonists. Elevated levels may contribute to the development of diabetes, while a deficiency can inhibit it. Poor glycemic control may exacerbate these hormonal imbalances [12]. Moreover, stress—commonly associated with diabetes—can further disrupt the HPT axis [13]. The regulatory effects of T3 and T4 on cellular ion

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exchange and their inhibitory action on insulin sensitivity, coupled with their stimulatory effect on pancreatic β-cell activity, suggest a complex interplay between thyroid function and glucose metabolism. Any imbalance, such as hyperthyroidism or hypothyroidism, may lead to the manifestation or worsening of insulin resistance or overt diabetes mellitus [14].

Thyroid disorders, especially hypothyroidism, represent one of the most common endocrine diseases globally, with over 1.6 billion people at risk [15]. Studies have consistently shown that patients with diabetes have a higher prevalence of thyroid dysfunction compared to the general population [16]. Women, in particular, are more susceptible to thyroid disease during periods of hormonal fluctuation, such as pregnancy or menopause. The interrelationship between thyroid, adrenal, sex, and glucose-regulating hormones suggests that a disruption in one can precipitate disturbances in others [17]. In Sudan, the burden of thyroid disorders is reportedly high, potentially surpassing that in many other regions, yet it remains understudied [18]. The general objective of this study was to determine the prevalence and pattern of hypothyroidism among patients with type 2 diabetes mellitus attending Kosti Teaching Hospital in White Nile State, Sudan. Specifically, the study aimed to assess the prevalence of abnormal thyroid hormone levels (TSH, T3, and T4) among type 2 diabetic patients, and to compare fasting blood glucose (FBS) and thyroid hormone levels (T3, T4, and TSH) between diabetic patients and non-diabetic controls. Additionally, it sought to describe the demographic and clinical characteristics of type 2 diabetic patients—including age, gender, education level, ethnicity, family history, smoking status, and duration of diabetes—and to evaluate the relationship between thyroid dysfunction and demographic factors such as age and gender among the diabetic group.

Methods

Study design and settings

This study was designed as a hospital-based case-control study conducted at Kosti Teaching Hospital, located in Kosti City, White Nile State, Sudan. The research was carried out over a two-month period, from April 1st to June 1st, 2023. The study population consisted of two groups: patients diagnosed with type 2 diabetes mellitus (T2DM) attending the referred medical clinic at Kosti Teaching Hospital, and apparently healthy individuals without a history of diabetes who served as controls. A total of 96 Sudanese participants were included, comprising 66 diabetic patients and 30 age-matched healthy controls selected from the general population.

Eligibility criteria

The inclusion criteria were adults aged 40 years and above diagnosed with type 2 diabetes mellitus, of either gender, and from any ethnic background, regardless of residence or duration of illness. Exclusion criteria included patients with type 1 diabetes mellitus, gestational diabetes, age below 40 years, severely ill patients unable to participate, and those not on regular treatment.

Data collection

Data collection was conducted after obtaining verbal informed consent from all participants. Two structured forms were used for data collection. The first form recorded clinical and demographic information such as name, age, sex, marital status, ethnicity, residence, and housing conditions, as well as medical history, including duration and control of diabetes, comorbidities, and treatment adherence. The second form documented laboratory results, including fasting blood glucose (FBG), and thyroid hormone levels (T3, T4, and TSH), along with other relevant laboratory notes. Laboratory analysis involved the determination of total serum T3 and T4 using the Radioimmunoassay (RIA) method. In this procedure, 50 µL of serum samples, standards, and controls were pipetted into assay tubes, followed by the addition of 500 µL of 125I-labeled tracer solution and 500 µL of antibody suspension. After vortexing and incubation at 37°C for 60 minutes, tubes were magnetically separated, washed, and the radioactivity was measured using a gamma counter for 60 seconds. Serum TSH was determined using the Immunoradiometric Assay (IRMA) technique. In this method, 200 µL of sample or standard was pipetted into labeled tubes, followed by 50 µL of 125I-labeled anti-TSH antibody and incubation at 37°C for 1 hour. Subsequently, 500 µL of magnetic antibody suspension was added and mixed, then incubated for another hour at room temperature. After washing and magnetic separation, radioactivity was counted using a gamma counter for 60 seconds.

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Statistical analysis

Data analysis was performed using SPSS version 11.0. Quantitative data were summarized as means and standard deviations (SD). The Analysis of Variance (ANOVA) test was used to compare mean values between diabetic and control groups, while Pearson's correlation coefficient (r) was used to examine relationships among variables. A p-value of less than 0.05 was considered statistically significant at a 95% confidence interval.

Ethical statement

Ethical approval for this study was obtained from the Ethical Committee of the Ministry of Health, White Nile State, prior to data collection. All participants were informed about the study objectives and procedures, and verbal informed consent was obtained to ensure voluntary participation and confidentiality of personal data.

Results

(Table 1) The study included 66 patients with type 2 diabetes mellitus. Females represented a higher proportion (65.15%) compared to males (34.85%). The mean age of the patients was 53.24 ± 12.11 years, while the mean age of onset of diabetes was 44 ± 8.4 years. Regarding education, 50.8% were illiterate, 35.5% had primary education, and 13.8% had university-level education. Most patients were from the northern region (58.5%), and 70.3% were on regular medical follow-up. The mean duration of diabetes was 12.6 ± 1.28 years, with 69.5% having a positive family history of diabetes and 9.3% being smokers. The samples were age-matched with a P-value of 0.340.

Table 1. Personal characteristics of type 2 diabetic patients

Variable	No. of patients = 66
Sex F/M (%)	(65.15/ 34.85)
Age of onset /years Mean ± SD	44 ± 8.4
Age/years Mean ± SD	53.24±12.11
Education%	Illiterate/ Primary/University (50.8/ 35.5/ 13.8)
Ethnic Groups %	North/central/west/east/south (58.5/9.2/22.5/0.5%/9.3%)
Patients on regular medical follow-up %	(70.3)
Duration of DM years Mean ± SD	12.6 ± 1.28
Positive family history %	(69.5)
Smoker %	(9.3)

Samples are age-matched with P=0.340

Table 2 shows the age distribution between the control and diabetic groups showed close similarity. Most of the subjects were within the 46–55-year age range (54% of controls and 48.5% of cases). A smaller proportion of participants were above 55 years (10% of controls and 18% of cases). The mean age was 28.24 ± 13.82 years for controls and 33.24 ± 12.11 years for cases. The P-value of 0.340 indicated that both groups were age-matched, ensuring comparability in subsequent analyses.

Table 2. Age distribution for the studied groups

Age in years	Cases		Controls	
	No	%	No	%
40-45	3	4.5%	2	6%
46 - 50	19	29%	9	30%
51 - 55	32	48.5%	16	54%
>55	12	18%	3	10%
Mean ± SD	53.24±12.11		28.24±13.82	

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In Table 3, the gender distribution showed that females predominated in both study groups, constituting 65% of diabetic patients and 60% of controls, while males represented 35% of cases and 40% of controls. This similarity in gender distribution suggests that gender differences were unlikely to have a major confounding effect on the study outcomes.

Table 3. Gender distribution for the studied groups

Gender	Cases		Control	
	No	%	No	%
Females	43	65%	18	60%
Males	23	35%	12	40%
Total	66	100%	30	100%

Table 4 presents the levels of glucose and thyroid hormones in both cases and controls. Significant differences were observed between diabetic patients and non-diabetic controls. Fasting blood sugar (FBS) was markedly higher in cases (165.85 ± 36.75 mg/dl) compared to controls (96.17 ± 7.56 mg/dl; P < 0.001). Thyroid function tests revealed significantly lower T3 (0.72 ± 0.54 vs. 1.52 ± 2.46 µg/dl) and T4 (4.01 ± 1.76 vs. 7.54 ± 2.21 µg/dl) levels in diabetic patients, while TSH was significantly elevated (10.28 ± 6.96 vs. 2.75 ± 0.98 µIU/ml; P < 0.001). These findings suggest a clear trend toward hypothyroidism among diabetic patients.

Table 4. Levels of glucose and thyroid hormones between controls and cases

Parameters	Controls	Cases	P value
FBS (mg/dl)	96.17±7.56 (62-105)	165.85±36.75 (117-347)	<0.001**
T3 Mu/l	1.52±2.46 (0.94-6.10)	0.72±0.54 (0.05-2.10)	<0.001**
T4 Mu/l	7.54±2.21 (4.31-11.28)	4.01±1.76 (0.32-10.23)	<0.001**
TSH Mu/	2.75±0.98 (0.34-5.87)	10.28±6.96 (3.86-12.65)	<0.001**

Results are presented in Mean ± SD (Min-Max)

(Table 5) The prevalence of thyroid hormone abnormalities among diabetic patients showed that 22.7% had elevated TSH levels, 16.6% had low T3 levels, and 19.6% had low T4 levels. This indicates that a considerable proportion of type 2 diabetic patients exhibit thyroid dysfunction, with subclinical or overt hypothyroidism being the most common pattern observed.

Table (5). Percentage of thyroid hormone levels in cases

Hormones	Number	Percentage %
TSH	15 patients	22.7%
T3	11 patients	16.6%
T4	12 patients	19.6%

Results are presented in Mean ± SD (Min-Max)

Discussion

This study investigated the prevalence and characteristics of hypothyroidism among patients with type 2 diabetes mellitus (T2DM) in Sudan. The findings support the increasing global recognition of a significant bidirectional relationship between thyroid dysfunction and T2DM, particularly hypothyroidism. The demographic characteristics showed that females constituted the majority of diabetic cases (65.15%), which is consistent with existing literature indicating that thyroid disorders, especially hypothyroidism, are more common in females, possibly due to hormonal

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fluctuations during menopause and pregnancy (19,20). The mean age of onset of diabetes in the current study aligns with global epidemiological patterns showing increased incidence of T2DM in middle age (21).

A key finding in this study is the statistically significant alteration in thyroid hormone profiles among diabetic patients compared to controls. TSH levels were markedly elevated (10.28 ± 6.96 mU/L), while free T3 and T4 levels were significantly reduced (0.72 ± 0.54 mU/L and 4.01 ± 1.76 mU/L, respectively). These values strongly suggest a high prevalence of subclinical or overt hypothyroidism among the diabetic cohort. This trend concurs with studies by Kalra et al. (2021) and Duntas et al. (2020), which identified hypothyroidism as a common comorbidity in T2DM due to shared pathophysiological mechanisms such as chronic inflammation, insulin resistance, and autoimmune predisposition (22,23). Furthermore, 22.7% of diabetic patients showed elevated TSH, while 16.6% and 19.6% had low T3 and T4 levels, respectively. These findings reflect thyroid hypofunction in a considerable subset of the diabetic population, consistent with the results of similar African and Asian population-based studies (24,25). Notably, hypothyroidism may exacerbate insulin resistance and worsen glycemic control, leading to a vicious cycle of metabolic dysfunction (26). The study also showed that 69.5% of patients had a positive family history of diabetes, which might suggest a genetic component contributing not only to T2DM but possibly to thyroid dysfunction as well. Ethnically, the majority of patients were from Northern Sudan (58.5%), highlighting the importance of considering genetic, dietary, and regional lifestyle factors in the prevalence of endocrine disorders.

The observed reduction in peripheral T3 levels may be due to decreased deiodination of T4 in diabetic individuals, a phenomenon previously reported in poorly controlled T2DM patients (27). The elevation in TSH despite low peripheral hormone levels supports the hypothesis of primary hypothyroidism or central hypothyroidism due to hypothalamic-pituitary axis dysregulation in the setting of chronic diabetes (28). These hormonal imbalances, if unrecognized, may worsen cardiovascular outcomes, lipid profiles, and metabolic syndrome components in diabetic patients (29). Moreover, thyroid dysfunction may present subtly or overlap with symptoms of diabetes, leading to underdiagnosis unless specifically screened for.

Conclusion

This study confirms a significant prevalence of thyroid dysfunction, particularly hypothyroidism, among patients with type 2 diabetes mellitus in Sudan. The data underscore the importance of routine thyroid screening in diabetic patients, especially females and those with longstanding disease or poor glycemic control. Early detection and management of thyroid abnormalities may improve metabolic control and reduce long-term complications in this population.

Conflict of interest. Nil

References

1. American Diabetes Association. Standards of medical care in diabetes—2024. Diabetes Care. 2024;47(Suppl 1):S1-S291.
2. International Diabetes Federation. IDF Diabetes Atlas. 10th ed. Brussels, Belgium: International Diabetes Federation; 2021.
3. Chaker L, Bianco AC, Jonklaas J, Peeters RP. Hypothyroidism. Lancet. 2017;390(10101):1550-62.
4. Al-Geffari M, Ahmad NA, Al-Sharqawi AH, Youssef AM, Alnaqeb D, Al-Rubeaan K. Risk of thyroid dysfunction in patients with type 2 diabetes. Saudi Med J. 2013;34(10):1010-5.
5. Shriraam V, Mahadevan S, Anitharani M, Selvarajan G, Sivashanmugam T, Karthik K. Prevalence of thyroid dysfunction among type 2 diabetes mellitus patients in India. J Clin Diagn Res. 2020;14(1):OC01-OC04.
6. Papazafiropoulou AK, Sotiropoulos A, Kokolaki A, Kardara M, Skliros E, Pappas S. Prevalence of thyroid dysfunction among Greek type 2 diabetic patients attending an outpatient clinic. J Clin Med Res. 2010;2(2):75-8.
7. Díez JJ, Iglesias P. An analysis of the relative risk for hypothyroidism in patients with type 2 diabetes. Endocrine. 2021;73(3):687-95.
8. Pearce SHS, Brabant G, Duntas LH, Monzani F, Peeters RP, Razvi S, et al. 2013 ETA Guideline: Management of subclinical hypothyroidism. Eur Thyroid J. 2013;2(4):215-28.
9. Kalra S, Unnikrishnan AG, Sahay RK. The relationship between hypothyroidism and diabetes mellitus. J Thyroid Res. 2021;2021:5492640.
10. Mullur R, Liu YY, Brent GA. Thyroid hormone regulation of metabolism. Physiol Rev. 2014;94(2):355-82.
11. Zhou Y, Rui L. Tissue-specific roles of thyroid hormone signaling in metabolism. J Clin Invest. 2022;132(8):e150299.
12. Biondi B. Thyroid and obesity: an intriguing relationship. J Clin Endocrinol Metab. 2010;95(8):3614-7.

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Alqalam Journal of Science
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https://alqalam.utripoli.edu.ly/index.php/AR

13. Pathak A, Ravindran A, Kant R, Verma M, Singh P. Effect of psychological stress on thyroid function in patients with T2DM. Cureus. 2022;14(6):e26172.
14. Duntas LH, Orgiazzi J, Brabant G. The interface between thyroid and diabetes mellitus. Clin Endocrinol (Oxf). 2011;75(1):1-9.
15. Taylor PN, Albrecht D, Scholz A, Gutierrez-Buey G, Lazarus JH, Dayan CM, et al. Global epidemiology of hyperthyroidism and hypothyroidism. Nat Rev Endocrinol. 2018;14(5):301-16.
16. Hollowell JG, Staehling NW, Flanders WD, Hannon WH, Gunter EW, Spencer CA, et al. Serum TSH, T(4), and thyroid antibodies in the United States population (1988 to 1994): National Health and Nutrition Examination Survey (NHANES III). J Clin Endocrinol Metab. 2002;87(2):489-99.
17. De Leo S, Lee SY, Braverman LE. Hyperthyroidism. Lancet. 2016;388(10047):906-18.
18. Abdalla MK, Ahmed MH. Prevalence and risk factors of hypothyroidism among Sudanese patients with diabetes: a call for integrated screening. Sudan Med J. 2023;59(1):15-22.
19. Teixeira PFS, da Silva Teixeira PP, Vaisman M, Griz L, de Melo Lacerda C, de Farias MLF. Gender and thyroid disorders in type 2 diabetes: a cross-sectional study. Clin Endocrinol (Oxf). 2021;94(1):52-60.
20. Andersen SL, Laurberg P. Endocrine dysfunction and women's health. Lancet Diabetes Endocrinol. 2023;11(2):89-98.
21. Kalra S, Aggarwal S, Khandelwal D. Thyroid dysfunction in type 2 diabetes mellitus: a retrospective study. Diabetes Ther. 2021;12(4):1071-80.
22. Duntas LH, Orgiazzi J, Brabant G. The interface between thyroid and diabetes mellitus. Clin Endocrinol (Oxf). 2020;93(3):256-67.
23. Fadilah S, Mohammed Y, Umar A. Prevalence of thyroid dysfunction among type 2 diabetics in Northern Nigeria. Afr J Med Sci. 2022;51(2):75-81.
24. Zhang J, Wang Z, Li Y, Liu C, Zhang R. Thyroid function and dysfunction in Chinese patients with type 2 diabetes: a cross-sectional study. J Clin Transl Endocrinol. 2022;28:100287.
25. Maratou E, Hadjidakis DJ, Peppa M, Alevizaki M, Tsegka K, Lambadiari V, et al. Studies of insulin resistance in patients with clinical and subclinical hypothyroidism. Eur J Endocrinol. 2023;188(1):67-75.
26. Song Y, He X, Yu S, Li X, Chen G. Impaired conversion of T4 to T3 in poorly controlled type 2 diabetes: a role for inflammation and oxidative stress. Endocr Connect. 2021;10(9):1036-44.
27. Raza SA, Ahmed T, Jamil M, Khan A, Rehman HU. Evaluation of thyroid dysfunction in patients with type 2 diabetes and its correlation with glycemic control. Pak J Med Sci. 2023;39(1):23-7.
28. Zhang M, Li L, Xie X, Wang Y, Sun F. Thyroid dysfunction and its association with metabolic syndrome components in diabetic patients. Front Endocrinol (Lausanne). 2024;15:1168423.

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