ORIGINAL RESEARCH

The Correlation between Type 2 Diabetes Mellitus and Hypothyroidism: A Cross-Sectional Study

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ABSTRACT

Introduction: Thyroid disorders and diabetes are interrelated endocrine conditions. Individuals suffering from either disorder are at a significantly increased risk for the development of the alternate condition. **Materials and Methods**: A cross-sectional observational study was conducted to evaluate the association between Type 2 Diabetes Mellitus (T2DM) and hypothyroidism. Demographic and clinical information was systematically gathered through the utilization of a structured questionnaire, in conjunction with patient medical records. The variables encompassed age, gender, the duration of diabetes, and the history of complications associated with diabetes. Venous blood samples were obtained following an overnight fasting period. Subsequently, fasting blood sugar (FBS), postprandial blood sugar (PBS), and a thyroid function profile were conducted. The analysis of the data was conducted utilizing the Statistical Package for the Social Sciences (SPSS), version 20.0. **Results**: The study included a total of 108 participants. The predominant age demographic within the population is between 41 and 60 years, with the 51–60 age cohort representing the largest segment, consisting of 40 individuals, or 37.03% of the overall population. A substantial proportion of individuals exhibit HbA1c levels exceeding 8, underscoring a notable issue regarding insufficient diabetes management within this population. A significant segment of the population is presently exhibiting initial indicators of renal dysfunction. Diabetic neuropathy emerged as the most prevalent complication, affecting 39 individuals, which constitutes 36.11% of the cohort. **Conclusion**: Regular assessments of diabetes mellitus should be conducted in patients with hypothyroidism to facilitate early diagnosis, ensure optimal treatment, and prevent complications.

Key Words: Coronary Artery Disease, Hypothyroidism, Type 2 Diabetes Mellitus, Retinopathy

INTRODUCTION

Hypothyroidism, also referred to as an underactive thyroid, is a medical condition characterized by insufficient production of thyroid hormones, specifically thyroxine (T4) and triiodothyronine (T3), by the thyroid gland. Autoimmunity frequently precipitates a pathological state targeting the thyroid gland, leading to its progressive deterioration and fibrosis, which subsequently results in a reduced or absent secretion of thyroid hormones [1]. Type 2 diabetes mellitus (T2DM) constitutes a chronic metabolic disorder arising from dysfunctions in pancreatic beta-cells and the presence of peripheral insulin resistance. The global prevalence is 9. 1%, corresponding to 415 million adults afflicted with the condition [2]. Type 2 diabetes mellitus (T2DM) is a multifaceted condition that results from the interplay between genetic predispositions and lifestyle determinants. Recent evidence has indicated that reduced circulating levels of thyroid hormones, even those within standard reference ranges, may be associated with an increased risk of developing Type 2

Diabetes Mellitus (T2DM), particularly among individuals with prediabetes [3]. Individuals diagnosed with type 2 diabetes mellitus exhibit an increased susceptibility to the development of thyroid disorders. Numerous patients with diabetes exhibit characteristics of thyroid dysfunction over an extended duration [4]. Uncontrolled type 2 diabetes mellitus has an impact on the plasma levels of both T3 and T4. A hypothesized explanation for the observed association between diabetes mellitus and hypothyroidism may be attributed to genetic, biochemical, or hormonal factors. Insulin resistance plays a significant role in the pathogenesis of hypothyroidism among individuals diagnosed with type 2 diabetes mellitus. The incidence of hypothyroidism in India is documented at 11%, in contrast to 2% in the United Kingdom and 4.6% in the United States. Females are disproportionately affected, comprising approximately 85% of the individuals diagnosed with the condition. In individuals with diabetes, hypothyroidism exacerbates hypertension, dyslipidemia, and cardiovascular disease [5]. Chronic complications and organ damage associated with type 2 diabetes mellitus (DM-II) encompass retinopathy, nephropathy, neuropathy, and coronary artery disease (CAD). Diabetes Mellitus Type II is associated with severe acute complications, including hypoglycemic coma and diabetic ketoacidosis, which place a significant burden on the nation's healthcare system and economy [6-8]. The screening of thyroid disorders among diabetic patients could facilitate the early intervention of both subclinical and overt hypothyroidism [9].

MATERIAL AND METHODS

A cross-sectional observational study was undertaken to evaluate the association between Type 2 Diabetes Mellitus (T2DM) and hypothyroidism. The research was conducted at Rama Medical College, Hospital & Research Centre, Mandhana, Kanpur Nagar, U.P., India over duration of one year, from January 2024 to December 2024. The research encompassed a total of 108 adult participants, all aged 21 years or older, who had been previously diagnosed with Type 2 Diabetes Mellitus. Participants were chosen from the outpatient department of General Medicine unit through the use of a convenience sampling technique.

Inclusion Criteria: Individuals of either gender. Individuals diagnosed with Type 2 Diabetes Mellitus for a minimum duration of six months. Patients who have expressed their willingness to participate and have provided informed consent.

Exclusion Criteria: Women in the post-menopausal phase. Patients presenting with additional comorbidities, such as cardiovascular diseases, as well as other disorders associated with endocrinology. Individuals with chronic alcoholism and tobacco smoking habits.

Collection of Data: Demographic and clinical data were systematically gathered through a structured questionnaire along with patient records. The variables considered in this analysis encompassed age, gender, the duration of diabetes, and the history of complications associated with the condition. Laboratory Analyses Venous blood specimens were obtained following a period of overnight fasting. The subsequent assessments were conducted: Fasting Blood Glucose (FBG) • Postprandial Blood Glucose (PLBG).
Thyroid Profile: The analysis includes measurements of Thyroid-Stimulating Hormone (TSH), Triiodothyronine (T3), and Thyroxine (T4). All laboratory investigations were conducted utilizing established enzymatic and immunoassay methodologies in a certified laboratory.

Statistical Analysis: The data analysis was conducted utilizing the Statistical Package for the Social Sciences (SPSS), version 20. 0. Continuous variables were represented by means and their corresponding standard deviations. Categorical variables were represented as percentages. The comparison between variables was conducted employing suitable statistical tests for determining significance.

RESULT

A total of 108 individuals participated in this study. Table 1 provides information regarding the age and gender of the study participants. The majority of participants included in this study were within the age range of 41 to 60 years.

Table No.1: Age and Gender wise distribution

Age	Male	Female	Total
21-30	01 (0.92%)	02 (1.85%)	03 (2.77%)
31-40	09 (8.33%)	12 (11.11%)	21 (19.44%)
41-50	13 (12.03%)	23 (21.29%)	36 (33.33%)
51-60	18 (16.66%)	22 (20.37%)	40 (37.03%)
61-70	05 (4.62%)	03 (2.77%)	08 (7.40%)

The predominant segment of the population is situated within the age bracket of 41 to 60 years. Specifically, the cohort aged between 51 and 60 years constitutes the most significant proportion, encompassing 40 individuals, which represents 37.03% of the overall population. Subsequently, the 41–50 age group is represented, comprising 36 individuals, which constitutes precisely 33.33%. Within both of these age

cohorts, the number of females exceeds that of males, indicating a greater representation of females in the middle-aged demographic. The demographic cohort aged 31 to 40 years comprises 21 individuals, accounting for 19.44% of the total population, with a higher representation of females compared to males. Conversely, the youngest cohort, comprising individuals aged 21 to 30 years, exhibits the smallest number of participants, with only three individuals representing a mere 2.77% of the sample, thereby highlighting a limited representation of younger adults. The most senior cohort, comprising individuals aged 61 to 70, consists of merely 8 members (7.40%), with a higher prevalence of males relative to females. This distribution contrasts with the pattern observed in the other age categories. In general, the demographic distribution exhibits a tendency toward an older and predominantly female population, particularly within the middle-aged cohorts.

Table No.2: Duration of Diabetes

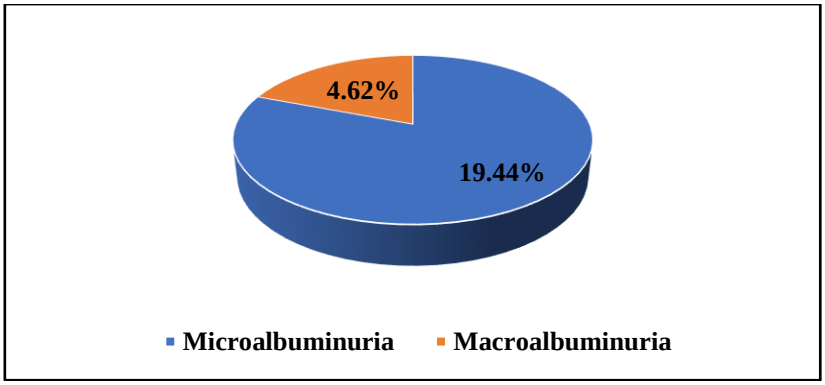
Duration	Number	Percentage
Below 1 year	23	21.29%
1-5 year	30	27.77%
6-10 year	29	26.85%
Above 10 year	26	24.07%

A substantial percentage of the participants, comprising 30 patients (27.77%), have been experiencing diabetes for a period ranging from one to five years, thereby identifying this as the most prevalent duration category. Subsequently, individuals with a history spanning 6 to 10 years constitute a notable proportion of the sample, numbering 29 patients, which represent 26.85% of the total. Meanwhile, those with disease durations exceeding 10 years account for 26 individuals, corresponding to 24.07% of the cohort. Concurrently, 23 patients, accounting for 21.29% of the sample, have received a diagnosis of diabetes within the past year, indicating a relatively recent onset of the condition. This distribution delineates a relatively uniform dispersion across varying durations, with a modest concentration evident in the early to mid-term phases of the disease. Furthermore, it underscores the significance of continuous surveillance and proactive intervention at all stages to avert the advancement of complications associated with diabetes.

Table No.3:Distribution according to Glycemic status

HbA1c	Number	Percentage
6.5-7	19	17.59%
7.1-8	28	25.92%
8.1-9	24	22.22%
Above 9	37	34.25%

The table delineates the distribution of individuals according to their HbA1c levels, which serve as a metric for evaluating long-term glycemic control in individuals diagnosed with diabetes. The data is categorized into four distinct HbA1c ranges, documenting both the number of individuals within each classification and the associated percentage. Within the 6.5–7 range, indicative of relatively well-managed diabetes, there are 19 individuals, comprising 17.59% of the total population. The range of 7.1–8 encompasses 28 individuals, accounting for 25.92% of the sample, thereby indicating moderately elevated blood glucose levels. The group with glycemic range between 8.1 and 9 consists of 24 individuals, comprising 22.22% of the sample population, which signifies inadequate glycemic control. The most substantial cohort is classified under the "Above 9" category, comprising 37 individuals, which corresponds to 34.25% of the sample, indicating a status of severely uncontrolled diabetes. In summary, the data indicates that a considerable proportion of individuals exhibit HbA1c levels exceeding 8, underscoring the issue of insufficient diabetes management within this population.



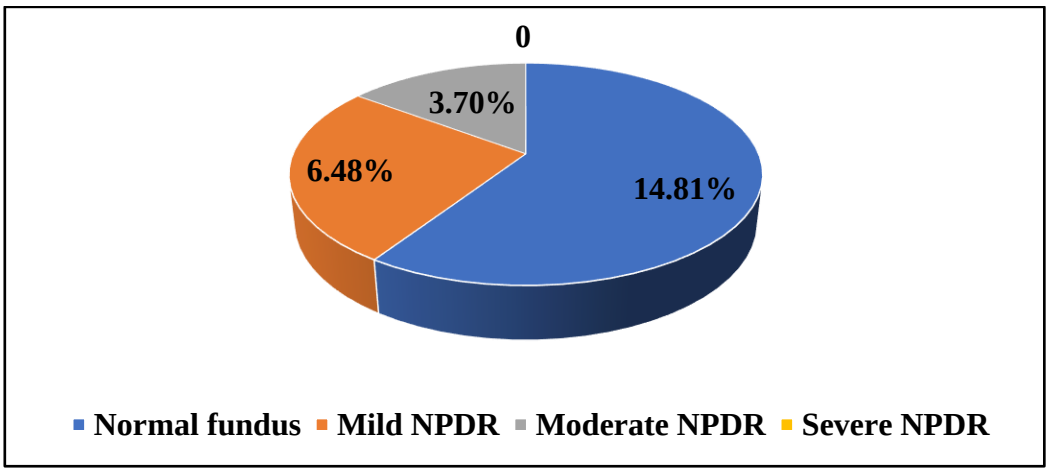
Graph No.1: Correlation of hypothyroidism with diabetic nephropathy

The graph illustrates the prevalence of albuminuria among individuals, categorized into microalbuminuria and macroalbuminuria, both of which serve as indicators of renal health. Microalbuminuria defined as a slight increase in albumin levels in the urine and frequently indicative of incipient renal impairment. Microalbuminuria was detected in 21 participants, representing 19.44% of the cohort. Conversely, macroalbuminuria, indicative of a more advanced stage of renal impairment characterized by elevated concentrations of albumin in the urine, was observed in five individuals, comprising 4.62% of the sample. This indicates that a significant segment of the population is currently exhibiting early indicators of renal dysfunction, whereas a smaller proportion has advanced to more severe stages of renal impairment. The early identification of microalbuminuria is of paramount importance, as it affords an opportunity for timely intervention with the aim of preventing further renal damage.

Table No.4: Correlation of hypothyroidism with diabetic neuropathy

Parameter	Number	Percentage
Normal VPT	18	16.66%
Abnormal VPT	12	11.11%
Mild neuropathy		
Severe neuropathy	09	8.33%

The table delineates the results of a Vibration Perception Threshold (VPT) evaluation, a diagnostic tool frequently employed to identify peripheral neuropathy, particularly among individuals with diabetes mellitus. Based on the data, 18 individuals, representing 16.66%, exhibited normal VPT readings, thereby indicating healthy nerve function. Abnormal vibration perception threshold (VPT) was detected in 12 individuals, constituting 11.11% of the cohort, thereby indicating preliminary indications of nerve dysfunction. Furthermore, a total of nine individuals (8. 33%) were diagnosed with severe neuropathy, indicative of substantial nerve damage. Nevertheless, it seems that the data pertaining to mild neuropathy is either absent or not reported. In summary, the findings indicate that a significant portion of the population demonstrates some level of neuropathic alteration, with smaller subset already experiencing severe nerve impairment. The existence of both abnormal and severe neuropathy underscores the necessity for regular screening and prompt intervention in order to mitigate progression.



Graph No.2: Correlation of hypothyroidism with diabetic retinopathy

The figure illustrates data obtained from a fundus examination, an assessment employed to evaluate retinal health and identify the presence of diabetic retinopathy. According to the findings, a total of 16 individuals, constituting 14.81% of the sample population, exhibited a normal fundus, thereby indicating an absence of diabetic retinal damage. Mild non-proliferative diabetic retinopathy (NPDR), indicative of initial retinal alterations associated with diabetes, was detected in seven individuals, representing a prevalence of 6.48%. Moderate Non-Proliferative Diabetic Retinopathy (NPDR), indicative of more advanced retinal involvement, was identified in four individuals, representing 3.70% of the cohort. It is noteworthy that the cohort did not exhibit any instances of severe Non-Proliferative Diabetic Retinopathy (NPDR). This observation indicates that although certain individual's exhibit early to moderate manifestations of diabetic retinopathy, none of them have advanced to the severe stage. This underscores the critical importance of ongoing monitoring and timely intervention to avert complications that could threaten vision.

Table No 4: Correlation of Thyroid function with Blood Glucose levels

Test	Type-2 diabetes with hypothyroid
FBS	168±6.91
PLBS	230±8.72
TSH	11.02±1.12
T3	1.011±0.023
T4	9.823±1.037

The test results suggest a diagnosis of Type-2 diabetes concomitantly occurring with hypothyroidism. The fasting blood sugar (FBS) measurement of 168±6.91 mg/dL and the postprandial blood sugar (PLBS) measurement of 230±8. 72 mg/dL both indicate significant elevations, thereby corroborating suboptimal glycemic regulation characteristic of Type-2 diabetes. Furthermore, the thyroid profile indicates evidence of hypothyroidism. Thyroid-stimulating hormone (TSH) levels are significantly elevated, recorded at 11.02±1.12 µIU/mL, exceeding the established normal reference range, thereby suggesting the presence of hypothyroidism. Concurrently, the concentrations of triiodothyronine (T3) at 1.011±0.023 ng/mL and thyroxine (T4) at 9.823±1.037 µg/dL fall within or marginally below the established normal reference ranges. This indicates a potential instance of subclinical or early-stage primary hypothyroidism, characterized by thyroid hormone levels that remain relatively intact, while the elevated thyrotropin (TSH) signifies the body's attempt to augment hormone production. The simultaneous presence of diabetes and hypothyroidism can exacerbate metabolic regulation difficulties, given that thyroid dysfunction may influence insulin sensitivity and lipid metabolism. This highlights the necessity for diligent monitoring and a comprehensive treatment approach.

Examination: Diabetes mellitus constitutes a multifactorial disorder characterized by a complex interplay between diabetes mellitus itself and thyroid disorders. Due to the intrinsic involvement of insulin and thyroid hormones in cellular metabolism, any abnormality in one of these hormones may lead to the functional derangement of the other. In our research, the middle-aged demographic groups, particularly those aged 41 to 60, represent the highest proportion of the population. Within this cohort, females generally outnumber males. This finding parallels a study conducted in Palakkad, as well as in eight additional cities across India, where an elevated prevalence of hypothyroidism was observed among women.

In this study, a notable proportion of participants, specifically 30 patients (27.77%), have been managing diabetes for a duration ranging from 1 to 5 years, thereby identifying this as the most prevalent duration category. There is a relatively equitable distribution across various durations, with a minor concentration observed in the early to mid-term stages of the disease. Additionally, it underscores the critical importance of continuous monitoring and timely intervention at all stages to avert the progression of complications associated with diabetes. Conversely, a noteworthy portion of individuals exhibit HbA1c levels exceeding 8, thereby underscoring a concern regarding insufficient diabetes management within this population. Analogously, the study conducted by Diez et al. found no statistically significant correlation between the presence of thyroid dysfunction and the duration of diabetes [12].

The mean duration of diabetes was 7.76 years with a standard deviation of 5.57 years, and the average HbA1c level was 8.17% with a standard deviation of 1.66%. A mere 29 patients, accounting for 38.6% of the sample, achieved an HbA1c level below 7%. Nonetheless, investigations conducted by Schlienger et al. , Bazrafshan et al., and Ardekani et al. have revealed a statistically significant increase in thyroid dysfunctions among diabetic individuals exhibiting elevated HbA1c levels [13-15]. A study conducted by Metab Al-Geffari et al. demonstrated that the duration of diabetes, specifically exceeding ten years, constituted a significant risk factor for the development of thyroid dysfunction within the population of type 2 diabetic patients examined in their research [16]. Among the cohort of patients

diagnosed with hypothyroidism that were evaluated, diabetic neuropathy emerged as the most common complication, affecting 39 individuals, which constitutes 36.11% of the sample. This condition pertains to neural damage consequent to prolonged elevated blood glucose levels, resulting in symptoms such as pain, tingling, numbness, or weakness, particularly in the extremities. Diabetic retinopathy, a condition affecting the ocular system that may result in visual impairment or complete loss of sight if not appropriately managed, was identified in 27 individuals, comprising 25% of the sample population. Diabetic nephropathy, a significant complication affecting renal systems, was identified in 26 individuals, representing 24.07% of the study population. This condition entails the progressive impairment of the kidneys' filtration system, which may ultimately culminate in chronic kidney disease or end-stage renal failure. The data emphasizes the critical need for early diagnosis and efficient management of diabetes in order to prevent or delay the onset of complications that substantially affect patients' quality of life and long-term health outcomes.

According to Han et al., subclinical hypothyroidism may influence the progression of diabetic complications, demonstrating an overall odds ratio of 1.74 (95% CI: 1.34, 2.28) for diabetic nephropathy, 1.42 (95% CI: 1.21, 1.67) for diabetic retinopathy, 1.85 (95% CI: 1.35, 2.54) for peripheral arterial disease, and 1.87 (95% CI: 1.06, 3.28) for diabetic peripheral neuropathy [17]. Chen et al. identified subclinical hypothyroidism as a risk factor for nephropathy and cardiovascular disease in patients with type 2 diabetes [18]. In the research conducted by Devendra S. Chauhan and colleagues. Al. [19] observed a tendency for increased diabetic microvascular complications, namely neuropathy, retinopathy, and nephropathy, to be associated with elevated levels of TSH. In the cohort of patients with hypothyroidism, the prevalence of nephropathy, neuropathy, and retinopathy was observed to be 64. 29%, 60. 71%, and 64.29% respectively. In contrast, among euthyroid patients, the occurrence of these conditions was 26. 74%, 25%, and 29. 07% respectively.

CONCLUSION

Hypothyroidism demonstrated a significant correlation with diabetes mellitus, advancing age (above 60 years), and female gender. The female gender and advancing age (greater than 60 years) have been identified as independent risk factors for the development of hypothyroidism. Therefore, conducting regular assessments for diabetes mellitus in patients with hypothyroidism is advisable to facilitate early diagnosis and optimize treatment, thereby preventing potential complications. This is of significance because the manifestations of diabetes and hypothyroidism are similar, which may result in the oversight of a diabetes diagnosis. Individuals exhibiting diminished levels of thyroid hormones ought to be encouraged to implement salutary lifestyle modifications as a preventive measure against the onset of diabetes mellitus.

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