Prevalence and Associated Risk Factors of Hypothyroidism in Patients with Diabetes Mellitus

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ABSTRACT

Background: Diabetes mellitus (DM) and hypothyroidism are two prevalent endocrine disorders that significantly impact global health. The link between Diabetes mellitus and hypothyroidism is multifaceted, with emerging evidence suggesting a bidirectional relationship between the two disorders. **Objectives:** This study aims to investigate the prevalence of hypothyroidism in patients with type II DM and identify the associated risk factors contributing to this comorbidity. **Methods:** A cross-sectional study was conducted among type II DM patients. Information on demographic and anthropometric variables and additional information related to hypothyroidism were collected from structured questionnaires by face-to-face interview and data on clinical and biochemical parameters were obtained from medical records. Descriptive statistics and bivariate analysis were used with logistic regression with adjustment of potential confounders, and a p-value < 0.05 was taken as statistically significant. **Result:** The prevalence rate of hypothyroidism in type II DM was found 32.5%, which is higher in women (44.1%) than in men (21.1%). Some of the comorbidities (>2), female gender, dyslipidemia, and family history of hypothyroidism were associated with higher odds of hypothyroidism among type II DM patients. The hypothyroid patients had significantly higher BMI than non-hypothyroid (27.19 ± 3.10 kg/m2 vs. 26.23 ± 3.749kg/m2, p = 0.002). Similarly, in the case of HbA1c (p= 0.016), FBS (p = 0.005), PPBS (p=0.034) and TSH (p= 0.002) statistically significant difference was seen between hypothyroid and non-hypothyroid patients. **Conclusion:** Several factors were associated with an increased risk of thyroid dysfunction in patients with type II diabetes including being female and having multiple comorbidities. Additionally, certain blood markers like HbA1c, FBS, PPBS, and TSH showed a significant association with hypothyroidism. These results emphasize the importance of monitoring thyroid function and related

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risk factors in the management of type II diabetes patients to provide more targeted and effective care.

Keywords: Diabetes mellitus (DM), Hypothyroidism, Prevalence, Risk factors, Association, Comorbidities

INTRODUCTION

Diabetes is manifested as a group of metabolic disorders that results from pancreatic beta-cell dysfunction and peripheral insulin resistance with a common phenotype of increased blood glucose level (hyperglycemia) [1]. About 422 million people in the world have diabetes mellitus, the majority of being in low- and middle-income countries (WHO, 7 Dec 2022) [2]. Like diabetes, thyroid dysfunction is a spectrum of disorders of the thyroid gland which manifests either as hyper or hypothyroidism and is reflected in the circulating levels of TSH. Hypothyroidism is diagnosed biochemically, being defined as serum TSH concentrations above and thyroxine concentrations below the normal reference range [3].

Type II diabetes and thyroid dysfunction (prominently hypothyroidism) [4], are two major endocrine disorders diagnosed and found in clinical practice in different ages and different populations that typically call for lifelong monitoring and therapy. Hypothyroidism has been reported to be associated with T2DM in several studies. Some studies have suggested a bidirectional influence of diabetes and hypothyroidism upon each other [1,5]. Thyroid hormone has been demonstrated to regulate carbohydrate metabolism and pancreatic function [6]. Insulin resistance can develop in subclinical hypothyroidism as a result of a reduced rate of insulin-stimulated glucose transfer caused by a translocation of the glucose transporter type 2 gene (GLUT 2) [5]. Conversely, diabetes can variably influence thyroid function. For example, the response of TSH to thyrotropin-releasing hormone is impaired in diabetes, leading to hypothyroidism and concomitant lower T3 levels [1].

Similarly, many studies have concluded that patients with DM are at increased risk of thyroid disease more common in diabetic patients compared to non-diabetic patients. According to Elmenshawi, prevalence of hypothyroidism is 6% which increases to 10% - 26% in people with DM [7]. A recent study shows besides the effects due to high blood glucose in diabetics, low thyroid hormones independently increase the risk for cardiovascular diseases in both diabetic and nondiabetic patients. Both disorders have long-lasting negative consequences on cardiovascular health and mortality, with the former carrying a larger risk [7,8].

Thyroid hormone and insulin mutually affect each other and many risk factors could influence their co-existence. Some of the major factors include gender, central obesity, high HbA1c levels (above 7%), the duration of diabetes (over 5 years), how medications are taken, age, dietary habits, physical activity, family history, smoking, alcohol consumption, and various laboratory parameters. Additionally, DM nephropathy is associated with thyroid dysfunction in type II diabetes [4,9-12]. However, the actual association between thyroid dysfunction and diabetic complications is not clear. Some studies have reported that hypothyroidism may worsen glycemic control, dyslipidemia, hypertension, and cardiovascular risk in patients with T2DM [13]. Assessment of thyroid function in a rising diabetic population may be useful to enhance health care with a trend to examine thyroid function in diabetes and vice versa preventing the risk of developing chronic illness and fatal conditions. Different studies regarding prevalence and risk factors have been done by fellow scholars but studies to show an association between diabetes and hypothyroidism is missing in the context of Nepal. In this study, we aimed to investigate the prevalence and associated risk factors of hypothyroidism in patients with Diabetes Mellitus.

MATERIALS AND METHODS

Study Setting and Population

A cross-sectional study was conducted from 1st February 2023 to 30th March 2023 in Diabetes, Thyroid & Endocrinology Care Centre. The site was selected purposively.

Sample Size and Sampling Technique

Data were gathered using convenience sampling technique. The sample size was calculated using Cochran formula; $n_{\circ} = Z^2 pq/e^2$, where $n_{\circ}$=minimum sample size, z= standard normal variate, p= estimated prevalence, q = 1 – p, e = desired level of precisionor margin of error and confidence interval = 95%. Taking 95% confidence interval, 5% margin of error, z-score= 1.96 and estimated prevalence p= 50%, the sample size was calculated as 384.

Eligibility criteria

All patients with T2DM who were 18 years and older and had no previous exposure to radiation and surgery in the neck were included in the study. Similarly, pregnant women, patients on medications that could influence thyroid levels (such as

glucocorticoids or heparin), those with acute and chronic infections, liver or heart failure, congenital hypothyroidism, or hyperglycemic crisis and non-consenting patients were excluded in the study.

Sampling Procedure

After identifying the eligible patients seeking medical attention at the center were randomly chosen. Those patients were informed about the study and enrolled after their consent. Data was collected through direct interviews using a structured questionnaire.

Study Parameters

The data collection involved gathering information on socio-demographic and anthropometric parameters (age, gender, marital status, ethnicity, education, occupation, height, weight, and BMI), medication history (family history of hypothyroidism and DM), clinical and biomechanical parameters (blood pressure, glucose levels, thyroid hormone, and cholesterol), drug and disease-related factors (disease duration, complications, co-morbidities, and route of administration), and lifestyle and diet-related factors (diet and exercise).

Ethical Consideration

Before data collection, permission was obtained from the Diabetes, Thyroid & Endocrinology Care Centre and ethical approval was taken from the Institutional Review Committee (IRC-CiST) at the Central Institute of Science and Technology, affiliated with Pokhara University, Nepal (Ref. No:38/079/080).

Data Management, Processing, and Analysis

The data was entered into Microsoft Excel version 16.74 and analysed using IBM-SPSS 20.0 (IBM Corporation, Armonk, NY, USA). The Kolmogorov–Smirnov test was applied to test normality of the data. The descriptive data were analyzed using mean, median, frequency, and percentage. Bivariate analysis was used to assess the relationship between two variables. The Student pair t-test was used to determine changes in biochemical and metabolic parameters. Associations were tested using Pearson's chi-square test and logistic regression taking 95% confidence interval. $P< 0.05$ was considered statistically significant.

RESULTS

In this study, prevalence was initially obtained where 32.5% were diagnosed with hypothyroidism while, the majority, comprising two-thirds (67.5%) of the patients did not have hypothyroidism.

Socio-demographic Characteristics

In this study with 382 participants, there was balanced distribution of 50.8% men and 49.2% women. Age groups were well-represented, with 0.8% falling within 18-29 years, 24.9% between 30 and 49 years, the largest group being 50-69 years (56.8%), and 17.5% being over 70 years old. Marital status revealed a small percentage of unmarried participants (1.3%) and a substantial majority of married participants (92.7%). Educational attainment was diverse, with the majority having completed secondary level education (31%), followed by primary education (28%), and higher secondary education (18%). Social characteristics showed that 4.5% of the participants were regular smokers, while only 3.1% reported being regular consumers of alcohol. Regarding family medical history, a significant portion (58%) had a family history of diabetes, whereas 25% had a family history of hypothyroidism as illustrated in table 1.

Table 1: Sociodemographic characteristics.

Variables	Frequency (percentage)
Age	
Mean ± SD	58.16 ±11.70
18-29	3 (0.8%)
30-49	95 (24.9%)
50-69	217 (56.8%)
>70	67 (17.5%)
Gender	
Male	194 (50.8%)

Female	188 (49.2%)
Marital status	
Unmarried	5 (1.3%)
Married	354 (92.7%)
Widow/ Divorced	23 (6%)
Ethnicity	
Brahmin/Chhetri	138 (36%)
Newar	139 (36.4%)
Janjati	49 (12.89%)
Madhesi	18 (4.7%)
Dalit	3 (0.8%)
Other	35 (9.3%)
Education	
Illiterate	28 (7.3%)
Primary (6years)	108 (28.3%)
Secondary (10yrs)	117 (30.6%)
Higher secondary (12yrs)	68 (17.8%)
Graduate (15 to 16 yrs)	53 (13.9%)
Postgraduate (more than 16)	8 (2.1%)
Job employment	
Unemployed	8 (2.1%)
Retired	74 (19.4%)
Homemaker	139 (36.4%)
Business	65 (17%)
Service	57 (14.9%)
Farmer	6 (1.6%)
Other	33 (8.6%)
Smoking	
Yes	17 (4.5%)
No	365 (95.5%)
Family history	
Hypothyroidism	95 (25%)
Diabetes Mellitus	160 (42%)

Anthropometric Characteristics

The mean BMI was 26.5503, with a standard deviation of 3.81889. The median height was 155.00cm, with an interquartile range of 13.70cmn and the median weight was 66.30kg, with a interquartile range of 12.22kg.

Risk Factors

Out of the 382 patients, a considerable portion of individuals, namely 50.8%, exhibited prolonged disease duration of 10 years or more, while 39.3% manifested a relatively short disease duration of 5 years or less. Furthermore, 9.9% of the

patients endured an intermediate disease duration ranging from 5 to 10 years. Regarding comorbidities, a substantial majority of the patients, approximately 83.8%, presented with concurrent medical conditions in addition to the primary disease. Interestingly, only 5% of the patients were diagnosed with goiter, while a significant proportion, approximately 52%, suffered from hypertension. In terms of disease progression, a noteworthy segment comprising 22% of the patients experienced various complications during the ailment. Regarding therapeutic interventions, 69.4% of the patients were managed through oral therapy, while the remaining 30.6% required insulin administration. Dietary patterns were also assessed, with 13.4% of the patients adhering to a vegetarian diet, whereas the majority, accounting for 86.6%, followed a non-vegetarian dietary regimen. Physical activity levels were evaluated, and it was found that 84.3% of the patients engaged in some form of regular physical exercise, underscoring the significance of physical activity in disease management. Conversely, 15.7% of the patients did not partake in any physical exercise as shown in table 2. Among univariant analysis, gender (p<0.001), comorbidities (p<0.001), number of comorbidities (p<0.001), goiter (p=0.032), dyslipidemia (p<0.001), family history of DM (p =0-008) and hypothyroidism (p<0.001) showed associations shown in table 3. Furthermore, on multivariate analysis, only gender (p=0.004, CI=1.32-4.385, OR=2.417), number of comorbidities (OR=15.730, CI=8.58-28.96, p=< 0.001*), dyslipidemia (OR=2.03, CI=0.141-0.352, p= 0.021*) and family history of hypothyroidism (OR=2.39, CI=1.22-4.67, p=0.011*) showed association as presented in table 5.

Table 2: Suspected risk factors.

Variables	Frequency (Percentage)
Disease duration	
≤5 years	150 (39.3)
6-10 years	38 (9.9)
≥10 years	194 (50.8)
Comorbidities	
Yes	320 (83.8)
No	62 (16.2)
Presence of hypothyroidism	
Yes	124(32.5)
No	258 (67.5)
Presence of goiter	
Yes	18 (5)
No	364 (95)
Presence of hypertension	
Yes	199 (52)
No	183 (48)
Complication encountered	
Yes	84 (22)
No	298 (78)
Diabetic therapy	
Oral	265 (69.4)
Insulin	117(30.6)
Diet	
Vegetarian	51 (13.4)
Non-vegetarian	331 (86.6)
Exercise	
No exercise	60 (15.7)
Some exercise	322 (84.3)

Table 3: Association of possible risk factors with hypothyroidism and euthyroid.

Variables	Hypothyroidism (n=124)	Euthyroid (n=258)	χ^2 (p-value)
Gender			
Female	83 (44.1%)	105 (55.9%)	23.067 (**<0.001**)
Male	41(21.1%)	153 (78.9%)	
Comorbidities			
Yes	121 (37.8)	199(62.2)	25.757 (**<0.001**)
No	3(4.8)	59(95.2))	
Hypertension			
Yes	69(34.7)	130(65.3)	0.928 (0.335)
No	55(30.1)	128(69.9)	
Goiter			
Yes	10(55.6)	8(44.4)	4.596 (**0.032**)
No	114(31.3)	250(68.7)	
Dyslipidemia			
Yes	75(49.7)	76(50.3)	33.727 (**<0.001**)
No	49(21.2)	182(78.8)	
Diabetic therapy			
Oral	85(32.1)	180(67.9)	0.59 (0.809)
Insulin	39(33.3)	78(66.7)	
Family history of Hyperthyroidism			
Yes	49(51)	47(49)	20.192 (**<0.001**)
No	75(26.2)	211(73.8)	
Family history of DM			
Yes	84(37.8)	138(62.2)	6.990 (**0.008**)
No	40(25)	120(75)	
Exercise			
Yes	99(30.7)	223(69.3)	2.752 (0.097)
No	25(41.7)	35(58.3)	
Diet			
Veg	21(41.29	30(58.8)	2.039 (0.153)
Nonveg	103(31.1)	228(68.9)	
Complications			
Yes	28(33.3)	56(66.7)	0.037 (0.847)
No	96(32.2)	202(67.8)	
Smoking			
Smoker	2(11.8)	15(88.2)	4.478 (0.107)
Non-smoker	115(33.8)	225(66.2)	
Ex-smoker	7(28)	18(72)	
Alcoholism			
Alcoholic	3(25)	9(75)	9.817 (**0.028**)
Non-alcoholic	108(36.2)	190(63.8)	
Ex-alcoholic	2(20)	8(80)	
Occasional drinker	11(17.7)	51(82.3)	
Disease duration			
≤5 years	46(30.79	104(69.3)	0.818 (0.664)
6-10 years	11(28.9)	27(71.1)	
>10years	67(34.5)	127(65.5)	
BMI			
Underweight	0	4(100)	4.501 (0.105)
Healthy weight	37(28.99)`	91(71.1)	
Overweight	87(34.8)	163(65.2)	

Table 4: Clinical parameters.

Variables	Median (interquartile range)	p value
BMI	26.5503 (3.8189)	**0.022***
Glucose level		
HbA1C (%)	6.90 (1.55)	**0.016***
Fasting glucose	115 (46)	**0.005***
Postprandial glucose	159 (77.50)	**0.034***
Thyroid hormones		
TSH (n=244)	2.88 (2.82)	**0.002***
T3(n =118)	4.07 (1.52)	0.586
T4 (n= 115)	14.16 (4.68)	0.404
Cholesterol		
Triglycerides (n=372)	133 (81.50)	0.627
Total cholesterol (n=373)	145 (43.50)	0.658
High density lipoprotein (n =372)	42 (8.50)	0.032
Low density lipoprotein (n= 371)	85 (34)	0.124
Blood pressure		
Systolic	120 (10)	0.498
Diastolic	80 (10)	0.091

Table 5: Multivariate analysis for possible risk factors of hypothyroidism in type II DM patients.

Variables	COR	95%CI	p-value	AOR	95%CI	p-value
Gender						
Male	**Ref**			**Ref**		
Female	2.950	1.883-4.622	**<0.001***	2.417	1.32-4.385	**0.004***
Comorbidities						
Yes	11.958	3.66-38.986	**<0.001***	2.035	0.563-7.35	0.278
No	**Ref**			**Ref**		
No. of comorbidities						
<2	**Ref**			**Ref**		
>2				15.730	8.58-28.96	**<0.001***
Goiter						

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Absence	**Ref**			**Ref**		
Presence	2.741	1.054-7.129	**0.032***	1.815	0.438-6.825	0.378
Dyslipidemia						
Absence	**Ref**			**Ref**		
Presence	3.665	2.34-5.74	**<0.001***	2.037	1.12-3.73	**0.021***
Family history of DM						
Yes	1.826	1.16-2.86	**0.008***	1.328	0.563-7.352	0.355
No	**Ref**			**Ref**		
Family history of Hyperthyroidism						
Yes	2.933	1.87-4.73	**<0.001***	2.395	1.22-4.67	**0.011***
No	**Ref**			**Ref**		

Clinical Parameters

Concerning glucose level, the median (IQR) of HbA1c was found to be 6.90 (1.55), fasting glucose exhibited a median (IQR) of 115 (46) and postprandial glucose, on the other hand, displayed a median (IQR) of 159 (77.50).

TSH level, an indicator of thyroid function, was observed with a median (IQR) of 2.88 (2.82). T3, another thyroid hormone, had a median (IQR) of 4.07 (1.52), while T4 exhibited a median (IQR) of 14.16 (4.68), both of which are important markers of thyroid activity.

Moving to cholesterol levels, the median (IQR) of triglycerides was measured at 133 (81.50) and total cholesterol was found to have a median (IQR) of 145 (43.50). HDL cholesterol, often referred to as "good" cholesterol, had a median (IQR) of 42 (8.50). Conversely, LDL cholesterol, known as "bad" cholesterol, exhibited a median (IQR) of 85 (34).

Regarding blood pressure, the median (IQR) for systolic and diastolic readings was 120 (10) and 80 (10) respectively. Notably, associations were observed with HbA1C (p=0.016), Fasting Blood Sugar (FBS) (p=0.005), Postprandial Blood Sugar (PBBS) (p=0.034), and TSH (p=0.034), suggesting potential correlations between these variables and blood pressure measurements as portrayed in table 4.

DISCUSSION

The prevalence of hypothyroidism in people with diabetes was found to be 32.2%. A similar result was observed in another study by Khatiwada et al. where 36.03% of individuals had thyroid dysfunction [4]. However, a study conducted by Baral et al. reported a lower prevalence of hypothyroidism at 17.9% [14]. Similarly, Nair et al. found a prevalence of 15.71% in their study involving 1152 patients [8]. Another study by Elmenshawi estimated the prevalence of hypothyroidism to be 25%, with 31% of all thyroid dysfunctions [7]. In Egypt, a study showed a prevalence of 28.5% for hypothyroidism. On the other hand, a study by Papazafiropoulou found a slightly different and lower prevalence of 8% for hypothyroidism [15]. These variations in results may be influenced by factors such as the size of the study sample and the location of the research, considering this study was conducted at an endocrinology center where patients with multiple metabolic disorders tend to seek treatment.

In present study, we investigated various potential risk factors that could contribute to the development of hypothyroidism in individuals with diabetes mellitus. Our findings revealed that the prevalence of hypothyroidism in individuals with diabetes mellitus is higher among females (44.1%) as compared to males (21.4%). According to the study conducted by Nair et al., found that 36.2% male and 63.7% female had

hypothyroidism 8. Similarly, in the study by Papazafiropoulou, reported a prevalence of 21.6% in males and 78.4% in females [15]. In contrast to the result, Baral et al., reported a male predominance with a prevalence of 18.36% compared to 16.97% in female [14].

In the multivariate analysis, the association between gender and hypothyroidism was found to be significant (p<0.001) with an OR of 2.417 (CI = 1.32 - 4.385). A similar result was obtained in the study by Song et al., where the OR was 2.02 (CI=1.05 - 3.87) [16]. This gender difference in the prevalence of hypothyroidism can be attributed to the autoimmune nature of many thyroid disorders. Autoimmune diseases tend to occur more frequently in women, possibly due to the effects of sex steroids on the immune system, as mentioned by Mulder [17].

In further analysis, we investigated the relationship between comorbidities and hypothyroidism in individuals with diabetes mellitus. it was found that hypothyroidism is associated with the presence of comorbidities, particularly when there are more than two comorbidities present. Additionally, we observed that hypothyroidism was more commonly found in patients with comorbidities such as dyslipidemia and goiter. Interestingly, previous studies by Gyawali et al. have also reported a higher prevalence of hypothyroidism among patients with metabolic syndrome, supporting our findings [18]. This finding suggests that having multiple comorbidities, especially those associated with metabolic syndrome, may increase the likelihood of developing hypothyroidism.

In the present study, it confirmed that there is an association between hypothyroidism and dyslipidemia in patients with diabetes mellitus (OR=2.037, CI=1.12-3.73, p=0.021). This finding is consistent with a study conducted by Nair et al. where they found an independent association between dyslipidemia and hypothyroidism through univariant analysis (p <.001)8. Similarly, a study conducted in Columbia by Landázuri et al. focusing on the relationship between dyslipidemia and thyroid disease showed relationship in multivariate models (OR=2.5, p=0.001) [19]. But Khassawneh et al. found no association between hypothyroidism and dyslipidemia (p=0.220) [20]. On the other hand, we did not found a significant association between hypertension and hypothyroidism (p = 0.335), which is consistent with the findings of Ogbonna & Ezeani (p=0.43) [9]. These result were not consistent with Khatiwada et al. (p=0.046) which showed associations of hypertension with hyperthyroidism [4].

While the presence of goiter showed an association in the univariate analysis (p = 0.032). However, it is worth noting that a study by Smithson, identified goiter as a risk factor for hypothyroidism in their logistic regression analysis [21]. Similarly, Khassawneh et al. also found a strong association between hypothyroidism and goiter (OR=2.904, CI=1.118–7.547, p=0.029) [20]. Overall, the study supports the association between dyslipidemia and hypothyroidism in patients with diabetes mellitus, while the relationship with hypertension and goiter may require further investigation as findings is different in different studies.

In the present study, it was found that a family history of hypothyroidism was associated with an increased occurrence of hypothyroidism (OR=2.395, CI=1.22-4.67, p=0.011). This finding aligns with the study conducted by Khatiwada et al. where they observed a significant association between hypothyroidism and a family history of the condition (p<0.001) [4]. Regarding family history of diabetes mellitus (DM) as a risk factor, we confirmed its significance in the chi-square test ($\chi 2$=6.990, p=0.008), but logistic regression analysis did not find strong evidence supporting this relationship (p=0.355). This result is consistent with the findings of Ogbonna & Ezeani who also did not observe a significant association between a family history of DM (OR=3.3, CI=1.5-7.9, p=0.012) and the occurrence of hypothyroidism [9].

Among the social characteristics examined in our study, smoking (p=0.107) did not show a significant association as a risk factor for hypothyroidism. This finding aligns with the results of the study conducted by Song et al., which also reported an association between hypothyroidism and smoking to be negative (OR=0.46, CI=0.19-1.12, p<0.001) [16]. However, alcoholism was found to be associated with hypothyroidism in the univariate analysis.

Additionally, we did not find a significant association between disease duration and hypothyroidism (p=0.664) in our study, which is consistent with the findings of Khatiwada et al. (p=0.197)4. On the contrary, Song et al. found significant associations between hypothyroidism in diabetes mellitus with both disease duration (p=0.001) and drug therapy (p=0.036) [16].

In the present study, we also found an association between hypothyroidism and various continuous variables. The distribution of BMI, HbA1c, FBS, PBBS, and TSH differed across different categories of hypothyroidism. Specifically, our results indicated a statistically significant association between hypothyroidism and BMI. The mean BMI of individuals with hypothyroidism (M = 27.1926) was found to be significantly higher than the mean BMI of individuals without hypothyroidism (M = 26.2399) with a p-value of 0.022. This finding is supported by a study Jun et al. ($p<0.001$), which also demonstrated an association between hypothyroidism and BMI [22]. However, in the case of FBS and HbA1c, Jun et al. (p=0.369, 0.168) and Khatiwada et al. [4] (p=0.057, 0.076) did not found a significant association. Furthermore, our study observed a significant difference in median TSH levels between individuals with hypothyroidism and those without. Significant median difference of TSH with hypothyroidism was observed in studies like Song et al. [16] and Khatiwada et al. [4] ($p<0.001$). The difference in the results could be because of the size of the group of people studied. If the group was small, it may not have had enough statistical power to detect significant associations between the variables. Also, the study design being cross-sectional means it can only show a snapshot of the variables at one point in time, and it can't establish cause-and-effect relationships. To make the findings more reliable, future studies should include larger and more diverse groups of people and use longitudinal designs that follow them over time. This would help confirm and build upon these findings.

CONCLUSION

The study initially identified prevalence to be 32%. There was significant association between hypothyroidism and other factors such as gender, dyslipidemia, family history of hypothyroidism and number of comorbidities. Furthermore, continuous variables like HbA1c, FBS, PBBS and TSH also showed association. However, associations with some other factors such as smoking, and disease duration were not statistically significant in our study. Conducting a longitudinal study with a larger sample size, recruiting participants from a broader geographic area, and implementing follow-up studies would lead to more statistically powerful, generalizable findings and a deeper understanding of the relationships between hypothyroidism and associated factors in individuals with diabetes mellitus.

LIMITATIONS

Our study's capacity to establish strong conclusions is constrained by its small sample sizes and reliance on cross-sectional designs. Furthermore, its validity is undermined by a lack of thorough assessments and a failure to account for various contributing factors, which collectively impede the overall reliability of its findings. Atlast, our study couldnot meet total sample size because two patients had incomplete information so they were excluded in the main analysis.

DATA SHARING STATEMENTS

All the data supporting the findings are within the manuscript. Additional detailed information and raw data are available from the corresponding author on reasonable request.

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AUTHOR CONTRIBUTIONS

AL and PP developed the study concept; AL, PP, SK and RS conducted the data mining and analysis; AL, PP and SP wrote the manuscript, which was reviewed and edited by all authors.

DECLARATION OF CONFLICTING INTERESTS

The authors declared that they have no conflict of interest.

ETHICAL APPROVAL

Ethical approval was obtained from the Institutional Review Committee (IRC-CiST) of Central Institute of Science and Technology (Ref.No:38/079/080).

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INFORMED CONSENT

The patients were informed about the details of the study, and their written consent was obtained prior to data collection.

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