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ORIGINAL ARTICLE

Prevalence of Thyroid Dysfunction in Patients with Prediabetes and Its Correlation to Cardiovascular Risk

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ABSTRACT

Background:
Thyroid problems are more common in people with diabetes mellitus, according to several researches. Thyroid dysfunction may have a negative impact on metabolic regulation and increase the risk of cardiovascular illnesses in a situation where they are already predisposed. So, the work aims to evaluate the prevalence of thyroid dysfunction in prediabetic patients and to correlate thyroid abnormalities with cardiovascular risk**.**
Patients and Methods: This case-control study was conducted in an outpatient clinic, Faculty of Medicine, Zagazig University, on 100 cases during the period from March 2023 to September 2023. They were classified into two groups: Group (A): 50 apparently healthy individuals as the control group. Group (B): 50 confirmed prediabetic cases. **Results**: Group B had significantly higher glycemic parameters and triglyceride (TG) than group A and lower high-density lipoprotein (HDL-c). It was found that the prevalence of thyroid dysfunction in group B was 16% as 8% have a subclinical hypothyroidism (SH), 4% have a goiter, and 4% have Hashimoto's thyroiditis while all controls in group A were normal. Thyroid hormones and antibodies were significantly higher in group B than in group A, P<0.001. Electrocardiogram (ECG) shows 12% of the group (B) have ischemic changes and 4% have sinus tachycardia. Left ventricular ejection fraction (LVEF) was significantly lower in the prediabetic group, P=0.02, and Framingham's score was significantly higher in the prediabetic group, P<0.001. By logistic regression analysis, old age (OR = 3.2, p = 0.003), obesity (OR = 2.4, p = 0.001), HbA1c ≥6 (OR = 4.6, p = 0.032), and framingham score ((≥8) (OR = 4.7, p = 0.001) were risk factors for thyroid dysfunction.
Conclusion: Patients with prediabetes have an increased prevalence of thyroid dysfunction mainly SH and they are at higher cardiovascular risk than the normal population.
Keywords: Thyroid Dysfunction, Prediabetes, Cardiovascular Risk

INTRODUCTION

One of the main causes of mortality, diabetes mellitus is a chronic, non-communicable disease that burdens families and society everywhere it occurs, including Egypt [1]. Pre-diabetes is the state that occurs before diabetes, and it usually results in the development of diabetes [2]. Approximately 69.2% of people with prediabetes reside in low- and middle-income nations. It is projected that by 2045, the prevalence will rise to 8.3% of the world's adult population, or 587 million people (3.4). In patients with prediabetes, typical consequences of diabetes mellitus related to chronic hyperglycemia may already be apparent [5]. It is well recognized that problems with insulin metabolism can lead to abnormalities in thyroid function, which in turn affect insulin metabolism due to an imbalance in thyroid hormones [6].

Patients with metabolic syndrome are more likely to have subclinical hypothyroidism, which is understandable given the co-occurrence of insulin resistance, obesity, hypertension, and altered blood lipid content in both of these disorders [7].

Patients with diabetes who have hypothyroidism experience worsening dyslipidemia, hypertension, and cardiovascular disease. Diabetes-related cardiovascular problems may get worse if hypothyroidism from dyslipidemia coexists. Patients with diabetes can receive early therapy for both overt and subclinical thyroid dysfunction by having their thyroids screened for abnormalities. Therefore, in order to stop the progression of diabetes problems, people with hypothyroidism must be identified and treated [8]. According to a clinical trial investigation, prediabetes mellitus is linked to poor cardiovascular outcomes [9]. Patients with diabetes are more likely to have thyroid dysfunction than those with prediabetes, whose symptoms are less obvious and have thus far received less attention. The frequency of thyroid malfunction and the potential for elevated cardiovascular risk in individuals with prediabetes have not been well studied. So, the work aims to evaluate the prevalence of thyroid dysfunction in prediabetic patients and to correlate thyroid abnormalities with cardiovascular risk.

SUBJECTS AND METHODS

This case-control study was conducted at an outpatient clinic, Faculty of Medicine, Zagazig University, during the period from March 2023 to September 2023, on 50 patients with prediabetes and 50 healthy individuals with age and sex matching. Written informed consent was obtained from all patients, and the study was accepted by the Research Ethical Committee of the Faculty of Medicine, Zagazig University (ZU-IRB#10627-2-4-2023). The study was carried out according to the code of ethics of the World Medical Association (Declaration of Helsinki) for studies including humans. **Inclusion criteria:** All prediabetic patients (HbA1c from 5.7% to 6.4%) without thyroid surgery and without a history of prior neck radiation exposure. older than eighteen years old. all sexes. People permitting the study. **Exclusion criteria:** patients <18 years of age. those who have had neck surgery or trauma in the past. ladies who are nursing or pregnant. individuals who have already experienced radiation exposure in the neck. patients who refuse to consent. Individuals taking beta-blockers, carbimazole, propylthiouracil, potassium iodide, Lugol's iodine, lithium, amiodarone, and iodides. those with established thyroid conditions. anyone who has ever had thyroid therapy, such as medication (L-thyroxine, antithyroid medication), surgery, or head and neck radiation. those who have been exposed to iodinated contrast material within the last six months. those who have previously experienced cancer. People who have already experienced autoimmune disorders or other endocrine disorders. Patients previously diagnosed as having type 1 diabetes (T1DM). Patients were classified into two groups**: Group A** included 50 apparently healthy individuals as a control group. **Group B** included prediabetic cases. All patients were subjected to the following:

History-taking includes age, smoking, as well as gender. prior findings of thyroid disorders, hypertension, or hyperglycemia. length of the illness. comorbid conditions. abnormality of lipids. prior thyroid surgery. past use of lipid-lowering, antihypertensive, and/or antidiabetic medications. History of thyroid treatment, including medication, head and neck surgery, or radiation therapy. Nutritional status of iodine General and local clinical examination, including weight, height, body mass index (BMI), and blood pressure. Laboratory examinations include complete blood picture **(**CBC), Hemoglobin A1C (HA1C), postprandial blood sugar (PPBS), lactate dehydrogenase (LDH), kidney function tests, and liver function tests are among the blood tests that measure blood sugar levels. Thyroid-stimulating hormone (TSH), triglyceride (TG), high-density lipoprotein (HDL-C), and thyroid antibody concentrations. Thyroid ultrasonography of all subjects was performed. Twelve-lead ECGs (recorded at 25 mm/s and 10 mm/mV voltages) were obtained from all patients on admission.

STATISTICAL ANALYSIS

Statistical analysis was done by SPSS v26 (IBM Inc., Armonk, NY, USA). The normality of the data distribution was assessed using histograms and the Shapiro-Wilks test. Quantitative parametric data were evaluated using an ANOVA (F) test and a post hoc Tukey test. The results were provided as mean and standard deviation (SD). Quantitative non-parametric data were compared between each group using the Mann-Whitney test and the Kruskal-Wallis test. The data were given as the median and interquartile range (IQR). Multivariate logistic regression analysis was done to detect predictors for thyroid dysfunction in prediabetic patients. The Chi-square test was used to examine the frequency and percentage (%) of the qualitative variables. A P value with two tails $\leq$ 0.05 was deemed statistically significant.

RESULTS

The age of the included participants ranged from 22-60 years. The majority of group A was females (52%) while the majority of group B was males

(62%). the majority of included participants was non-smokers. The Framingham score was significantly higher in group B than in group A (P value <0.001) as shown in table (1).FBS, PPBS, HBA1C, fasting serum insulin, HOMA-IR, TG, HDL-C, TSH, ANA, anti-TPO, and anti TG were significantly different between the studied groups (P value ≤0.001) as group B enrolled prediabetic had higher values than group A enrolled controls except for HDL-c as shown in table (2). Thyroid ultrasound and ECG for group B revealed 42 out of 50 (84%) patients were normal while that rest of the group 8 out of 50 patients had thyroid dysfunction in the form of SH 4 (8%), goiter 2 (4%) and Hashimoto thyroiditis 2 (4%) and ECG abnormalities in the form of ischemic changes 6 (12%), and sinus tachycardia 2 (4%) as shown in table (3). All group A controls had normal thyroid ultrasound and no abnormality was detected in ECG. LVEF was significantly lower in group B than in group A (P value = 0.02) as shown in table(4). Table 5; showed that old age (OR = 3.2, p = 0.003), obesity (OR = 2.4, p = 0.001), HbA1c ≥6 (OR = 4.6, p = 0.032), and Framingham score ((≥8) (OR = 4.7, p = 0.001) were risk factors for thyroid dysfunction

Table (1): Demographic and clinical data of the studied groups

		Group A (n=50)	Group B (n=50)	P value
Age (years)	**Mean ± SD**	38.76 ± 11.41	43.96 ± 10.4	0.019*
	Range	22 – 60	22 – 60	
Sex	**Male**	24 (48%)	31 (62%)	0.15
	Female	26 (52%)	19 (38%)	
BMI (kg/m^2)	**Mean ± SD**	27.01 ± 1.52	30.75 ± 4.9	<0.001*
	Range	20.7 - 29.6	19.8 – 41	
Smoking	**Yes**	15 (30%)	20 (40%)	0.29
	No	35 (70%)	30 (60%)	
SBP (mmHg)	**Mean ± SD**	123.6 ± 7.43	128.2 ± 8.1	0.003*
	Range	110 – 135	110 – 140	
DBP (mmHg)	**Mean ± SD**	75.3 ± 5.38	77.8 ± 8.0	0.06
	Range	65 – 85	65 – 95	
Framingham score	**Median**	2.2	6.2	<0.001*
	IQR	0.875 - 5.7	3.8 - 11.725	

BMI: body mass index, SBP: systolic blood pressure, DBP: diastolic blood pressure *: significant as P value ≤ 0.05

Table (2): Laboratory investigation of the studied groups

		Group A (n=50)	**Group B (n=50)**	**P value**
WBCs (x10^9/L)	**Mean ± SD**	6.16 ± 1.19	6.35 ± 1.43	0.47
	Range	4.4 - 9.9	4.2 – 13.2	
Platelets (x10^9/L)	**Mean ± SD**	320.58 ± 82.96	297.0 ± 73.9	0.13
	Range	169 – 429	198 - 400	
RBCs (x10^{12}/L)	**Mean ± SD**	4.65 ± 0.32	4.6 ± 0.33	0.44
	Range	4 - 5.2	4 - 5.2	
Hb (g/dl)	**Mean ± SD**	13.53 ± 0.7	13.5 ± 0.68	0.82
	Range	11.9 - 15.1	11.9 - 15.1	
LDH (U/L)	**Mean ± SD**	313.6 ± 56.29	328.3 ± 48.8	0.16
	Range	234 – 437	239 - 412	
FBS (mg/dL)	**Mean ± SD**	83.32 ± 8.06	108.2 ± 6.4	**<0.001***
	Range	70 – 99	100 - 122	
PPBS (mg/dL)	**Mean ± SD**	119.1 ± 10.26	165 ± 17.2	**<0.001***
	Range	97 – 135	141 - 199	
HBA1C (%)	**Mean ± SD**	5.26 ± 0.27	6.05 ± 0.17	**<0.001***
	Range	4.8 - 5.9	5.8 - 6.3	
	Mean ± SD	10.01 ± 5.31	20.8 ± 2.9	**<0.001***

Fasting serum insulin (µU/mL)	**Range**	2.9 - 26.7	3.11 - 42.3	
HOMA-IR	**Mean ± SD**	1.54 ± 0.22	4.218 ± 0.48	**<0.001***
	Range	1.1 - 1.9	3.1 – 5.3	
ALT (U/L)	**Mean ± SD**	25.42 ± 6.77	26 ± 5.2	0.63
	Range	14 – 39	15 - 38	
AST (U/L)	**Mean ± SD**	22.9 ± 6.27	21.5 ± 5.2	0.22
	Range	12 – 35	12 - 36	
Albumin (g/dL)	**Mean ± SD**	4.21 ± 0.38	4.24 ± 0.4	0.7
	Range	3.5 - 4.9	3.5 - 5.1	
Total bilirubin (mg/dL)	**Mean ± SD**	0.59 ± 0.18	0.64 ± 0.2	0.19
	Range	0.32 - 0.99	0.32 - 0.99	
Urea (mg/dl)	Mean ± SD	34.82 ± 6.65	35.44 ± 5.2	0.6
	Range	25 – 48	25 - 45	
Creatinine (mg/dl)	**Mean ± SD**	1 ± 0.21	0.98 ± 0.21	0.63
	Range	0.6 - 1.4	0.6 - 1.4	
T.Cholesterol (mg/dL)	**Mean ± SD**	156.58 ± 33.08	161.1 ± 27.1	0.45
	Range	98 – 213	110 - 215	
TG (mg/dL)	**Mean ± SD**	111.7 ± 16.04	134.0 ± 28.2	**<0.001***
	Range	78 – 155	98 - 210	
LDL Cholesterol (mg/dL)	**Mean ± SD**	85.03 ± 18.81	87.0 ± 42.8	0.76
	Range	67.9 – 99.1	42 – 131.8	
HDL Cholesterol (mg/dL)	**Mean ± SD**	63.18 ± 4.53	39.8 ± 6.1	**<0.001***
	Range	55 – 77	29 - 55	
TSH (mIU/L)	**Mean ± SD**	2.9 ± 0.86	3.8 ± 0.9	**<0.001***
	Range	0.9 - 4.4	0.9 – 12.8	
ANA	**Mean ± SD**	5.6 ± 2.15	13.58 ± 3.8	**<0.001***
	Range	3.2 - 25.1	1.9 – 22.3	
Anti-TPO (IU/mL)	**Mean ± SD**	43.5 ± 10.7	75.8 ± 13.9	**<0.001***
	Range	21 – 63	19 - 98	
Anti-TG (IU/mL)	**Mean ± SD**	65.6 ± 25.4	92.6 ± 20.8	**<0.001***
	Range	25 – 110	25 - 145	

WBCs: white blood cells, RBCs: red blood cells, Hb: hemoglobin, LDH: lactate dehydrogenase, FBS: fasting blood sugar, PPBS: post-prandial blood sugar, HOMA-IR: homeostatic model assessment for insulin resistance, ALT: alanine transaminase, AST: aspartate aminotransferase, TSH: thyroid stimulating hormone, ANA: antinuclear antibody, TPO: Thyroid peroxidase, TG: thyroglobulin, *: significant as P value ≤ 0.05.

Table (3): Thyroid dysfunction and ECG of Group B

		Group B (n=50)
Thyroid dysfunction	**Normal**	42 (84%)
	Thyroid dysfunction	8 (16%)
	Subclinical	4 (8%)
	Goiter	2 (4%)
	Hashimoto's thyroiditis	2 (4%)
ECG	**NAD**	42 (84%)
	Ischemic changes	6 (12%)
	Sinus tachycardia	2 (4%)

ECG: electrocardiogram

Table (4): LVEF, thyroid nodules and volume of the studied groups

		Group A (n=50)	Group B (n=50)	P value
Thyroid nodules	**Yes**	11 (22%)	23 (46%)	**0.011***
	No	39 (78%)	27 (54%)	
Thyroid volume (mL)	**Mean ± SD**	10.1 ± 1.5	11.7 ± 3.5	**0.003***
	Range	7.8 - 14.3	8.1 – 20.2	
LVEF (%)	**Mean ± SD**	64.6 ± 3.14	62.7 ± 4.9	**0.02***
	Range	58.4 - 69.3	50.1 - 69.3	

LVEF: left ventricular ejection fraction, *: significant as P value ≤ 0.05.

Table (5): Multivariate Analysis (logistic regression) of predictors/risk factors of thyroid dysfunction in prediabetes patients

Variables	OR	CI (95%)	Regression Coefficient	p-values
Old age	3.2	1.5-8.2	1.22	0.003
Obesity	2.4	1.3-5.4	-1.4	0.001
HbA1c (≥6%)	4.6	2.5-9.3	0.9	0.032
Framingham score ((≥8)	4.7	2.3-10.9	1.7	0.001

DISCUSSION

Prediabetes is a metabolic state that lies in between normoglycemia and diabetes. It is characterized by impaired glucose tolerance, which is defined as 140–199 mg/dL of glucose two hours after a meal, impaired fasting glucose of 100–125 mg/dL, and a HbA1c of 5.6-7.4%. A substantial burden on healthcare services is imposed by prediabetes, which is linked to a significant increase in cardiovascular morbidity and mortality. To prevent complications and the progression to overt diabetes, which has reached epidemic proportions worldwide, early and appropriate intervention is necessary **[8].** Important effects of thyroid hormones (THs) on cardiovascular (CV) function have been observed. Triiodothyronine (T3) reduces diastolic relaxation time and raises heart rate, stroke volume, and cardiac contraction force. An increase in blood pressure, primarily systolic blood pressure, and cardiac output accompany all of these effects. Several clinical investigations have documented the essential function of THs in the preservation of cardiac homeostasis, indicating that variations in the levels of THs in circulation have an adverse effect on the cardiovascular system **[10].** Thyroid dysfunction and hyperglycemia are closely related. Thyroid dysfunction is more common in diabetics than in the general population, and the two disorders usually coexist. In hyperglycemic individuals, undiagnosed thyroid dysfunction may increase the risk of cardiovascular disease already present. Blood glucose control and the avoidance of related morbidity are aided by the early diagnosis and treatment of thyroid dysfunction. The majority of research has been on thyroid dysfunction in people with diabetes. Thyroid status in prediabetic patients has not been extensively studied to date. Likewise, it is unknown how to screen for thyroid dysfunction in connection to blood sugar **[11].** This case-control study was conducted in an outpatient clinic, Internal Medicine Department, Faculty of Medicine, Zagazig University, on 100 cases, which were divided into 50 patients with prediabetes and 50 healthy individuals. To evaluate thyroid dysfunction in patients with prediabetes and stratify thyroid abnormalities with insulin resistance and cardiovascular risk according to the Framingham score. The study principle Finding Group B had significantly higher glycemic parameters and triglyceride (TG) than group A while lower high-density lipoprotein (HDL-c). It was found that the prevalence of thyroid dysfunction in group B was 16% as 8% have a subclinical hypothyroidism (SH), 4% have a goiter, and 4% have Hashimoto's thyroiditis while controls in group A were normal. Thyroid hormones and antibodies were significantly higher in group B than group A, P<0.001. Electrocardiogram (ECG) shows 12% of the group (B) have ischemic changes and 4% have sinus tachycardia. Left ventricular ejection fraction (LVEF) was significantly lower in prediabetic, P=0.02 and Framingham's score was significantly higher in prediabetic, P<0.001**.** By logistic regression analysis, old age (OR = 3.2, p = 0.003), obesity (OR = 2.4, p = 0.001), HbA1c ≥6 (OR =

4.6, p = 0.032), and framingham score ((≥8) (OR = 4.7, p = 0.001) were risk factors for thyroid dysfunction. In the current study, we found that BMI was higher in prediabetic patients than in the control group. **Fayed et al. [12]** found similar results, demonstrating that obesity is one of the known risk factors for prediabetes. Additionally, increased HOMA-IR readings reveal a strong correlation between obesity and insulin resistance. **Gholampour Dehaki et al. [13]** studied the prevalence of thyroid dysfunction in patients with impaired glucose metabolism compared to the control group. There was no significant difference among the groups as regards BMI. These findings could be explained by the fact that not all patients with prediabetes are obese. In the present study, we found that SBP was significantly different between the studied groups, while DBP was insignificantly different between the studied groups. SBP was significantly higher in prediabetic patients than in the control group. **Gholampour Dehaki et al. [13]** studied the prevalence of thyroid dysfunction in patients with impaired glucose metabolism compared to healthy controls. SBP was significantly higher among the studied groups, while DBP was insignificantly different between the studied groups. The increase of systolic blood pressure could be explained by RAAS activation that occurred as a consequence of Insulin Resistance induced hyperinsulinemia.

Our current results unmistakably showed that there were substantial differences between the groups under study in terms of WBCs, FBS, PPBS, HBA1C, fasting serum insulin, and HOMA-IR. In comparison to the control group, prediabetic patients had significantly higher levels of WBCs, FBS, HBA1C, HOMA-IR, PPBS, and fasting serum insulin. **Gholampour Dehaki et al. [13]** reported that FBS, HBA1C, and HOMA-IR were significantly different among the studied groups (prediabetic and healthy subjects). These results are expected, especially for the significant elevation of FBG-PPBG-HBA1C-insulin resistance in the prediabetic group, and for the significant elevation of WBCs in the prediabetic group, which could be explained by immune system activation during the pre-inflammatory state in the prediabetic group. The present study revealed that TG, LDL There were significant differences in T cholesterol, HDL cholesterol, and cholesterol across the groups under study, but not in T scores. Compared to the control group, prediabetic individuals had significantly higher levels of TG and LDL cholesterol. Patients with prediabetes had considerably lower HDL cholesterol than those in the control group. In agreement with our findings, **El-Eshmawy et al. [17]** showed that, in comparison to healthy patients, prediabetic subjects had considerably higher levels of TG, LDL cholesterol, and T cholesterol. Although prediabetic respondents' HDL cholesterol was much lower than that of healthy patients, the changes in their lipid profile were explained by the expected increase in insulin resistance. In the current study, we found that the prevalence of thyroid disorders was 16% among prediabetic patients, compared to 6% among healthy individuals. The higher increase of thyroid dysfunction in prediabetics could be explained by more exposure to viral infection with low immunity in the prediabetic state. (16%) patients had thyroid dysfunction as follows: 4 (8%) patients had subclinical hypothyroidism, 2 (4%) patients had goiter, and 2 (4%) patients had clinical hypothyroidism (Hashimoto's thyroiditis).In contrast with healthy people, 3 (6%) have subclinical hypothyroidism. Regarding thyroid US for prediabetic patients with thyroid dysfunction, 1 (12.5%) patient had normal ultrasound, 4 (50%) patients had nodules, 2 (25%) patients had thyroid enlargement, and 1 (12.5%) had decreased thyroid gland size. Similar findings were obtained by **Gholampour Dehaki et al. [13],** who reported that In a follow-up study carried out in Tehran, the prevalence of thyroid dysfunction was 19.3% and 13.5% among prediabetics and healthy controls, respectively.

In contrast with **Thapa et al. [18],** which revealed that Thyroid dysfunction was independently linked to prediabetes, and there was a substantial correlation between the two conditions, with thyroid dysfunction present in 26.4% of prediabetics and 14.9% in the normal group.

Our current findings clearly revealed that TSH was notably greater in patients with prediabetes compared to the control group.

This was following **Thapa et al. [18],** who stated that When compared to the healthy control group, the prediabetic group's TSH level was considerably greater. Within the investigated groups, we observed significant differences in anti-TPO, and anti-TG in the current study. When prediabetic individuals were compared to the control group, the level of anti-TPO and anti-TG was significantly higher. Similarly, anti-TPO and anti-TG antibodies were shown to be increased, according to **Sahu et al. [20**]. Patients with hypothyroidism who were prediabetic had considerably higher levels of anti-TG and anti-TPO antibodies. This can be explained by the higher prevalence of autoimmune-subclinical hypothyroidism among prediabetic patients.

Our current findings revealed that, regarding ECG among prediabetic patients, 6 (12%) patients had

ischemic changes, 2 (4%) patients had sinus tachycardia, and 42 (84% had normal ECG). LVEF was significantly lower in prediabetic patients than in healthy people. Similar findings were obtained by **Karki et al. [21].** Who reported that individuals with prediabetes tended to have a higher prevalence of cardiovascular disorders than individuals without diabetes, right? The biological plausibility of the link between cardiovascular disease and thyroid dysfunction in prediabetics may help to explain this conclusion. Hypothyroidism is associated with hypercholesterolemia, decreased endothelium-dependent vasodilation, a symptom of atherosclerosis, and left ventricular diastolic dysfunction that may be rectified with thyroxine medication. This was in concordance with **Fayed et al. [12],** who reported that Patients with prediabetes showed significantly elevated levels of all cardiovascular risk factors (CVR), with almost 50% displaying at least two risk factors. The odds of having a higher CVR were 2.64 times higher for people with prediabetes than for those without it. A sex-specific method called the Framingham Risk Score is used to calculate a person's 10-year cardiovascular risk. If the FRS is less than 10%, moderate if it is between 10% and 19%, and high if it is 20% or more, risk is deemed to be present. **[24]** According to the current study, prediabetic patients had a significantly higher Framingham score than healthy individuals. However, compared to prediabetic female patients (18%), (24%) of prediabetic male patients had a higher Framingham risk score. On the other hand, the male and female healthy individuals' Framingham scores were (16%) and (12%), respectively.

This was in accordance with **Kumari et al. [22], who** conducted a study using the Framingham Heart Scale to estimate the future 10-year cardiovascular and 8-year diabetes risk. To show that there was a statistically significant difference between the groups under study, they employed Framingham scoring. (prediabetes and normal population groups) regarding the Framingham scores. According to a recent study (NOV/2023) by **Ağgül Akbaş [23], there is** a significant relationship between thyroid disorder in the form of thyroid volume and the Framingham risk score. In patients with insulin resistance, there's a significantly higher CVD risk factor than in normal people. By logistic regression analysis, old age (OR = 3.2, p = 0.003), obesity (OR = 2.4, p = 0.001), HbA1c ≥6 (OR = 4.6, p = 0.032), and Framingham score ((≥8) (OR = 4.7, p = 0.001) were risk factors for thyroid dysfunction. These results agreed with the study of **Ogbonna et al. [25]** which reported that central obesity (OR = 2.5, 95%CI = 1.5–5.2, p = 0.001, HbA1c ≥7% (OR = 4.3, p = 0.025) and duration of DM >5years (OR = 3.3, p = 0.012) were significantly associated with thyroid dysfunction in T2DM patients in this study but the study revealed also that female gender (OR = 3.8, p = 0.002), is a significant factor which is not proven by our study. On the other hand, female gender was proven to be related to the presence of thyroid disorders by the study of **Wenhua et al. [26].**

LIMITATIONS

Our study is a single-center study with a small sample. We did not assess the relationship between thyroid dysfunction and diabetes complications. No follow-up was done for our patients.

CONCLUSION

The prevalence of thyroid dysfunction in prediabetic patients was 16%, according to our study, with increased cardiovascular risk. The most common thyroid abnormality was subclinical hypothyroidism. TSH was significantly higher in prediabetic patients than in the healthy population.

RECOMMENDATIONS

Given the potential correlation between thyroid dysfunction, prediabetes, and cardiovascular risk, healthcare providers may consider screening for thyroid dysfunction in prediabetic patients. Early detection and appropriate management of subclinical hypothyroidism may help reduce the associated cardiovascular risk factors, such as elevated cholesterol levels.

AUTHORS' CONTRIBUTIONS

YSMS and KAE designed and directed the study. ASS performed the investigations and analyzed the data. The final manuscript has been reviewed and approved by all authors.

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