

Thyroid Peroxidase Autoantibody Prevalence and Its Association with IA-2 Autoantibodies in Patients with Type 1 Diabetes Mellitus in Al-Najaf Province, Iraq

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ABSTRACT

Background: Type 1 diabetes mellitus (T1DM) is an autoimmune disease that may coexist with other organ-specific autoimmune conditions, particularly thyroid autoimmunity. Thyroid peroxidase antibodies (TPO-Abs) are important serological markers used to assess thyroid autoimmunity in patients with T1DM. **Objective:** This study aimed to determine the prevalence of TPO-Abs positivity and evaluate its association with IA-2A positivity and serum IA-2A levels among patients with T1DM in Al-Najaf Province, Iraq. **Methods:** A hospital-based analytical cross-sectional study was conducted at the Diabetes Center of Al-Sadr Medical City, Al-Najaf, Iraq, between September 2022 and May 2023. The study included 30 patients with T1DM and 20 apparently healthy controls. Serum TPO-Abs and IA-2 autoantibodies (IA-2A) were measured using enzyme-linked immunosorbent assays kits. **Results:** Patients with T1DM had significantly higher mean serum TPO-Ab levels than controls (77.56 ± 30.26 vs. 7.03 ± 0.84 IU/mL, $P = 0.027$). Similarly, IA-2A levels were higher in patients with T1DM than in controls (255.51 ± 118.43 vs. 4.92 ± 0.38 U/mL, $P = 0.043$). TPO-Ab positivity was detected in 9 of 30 patients with T1DM (30.0%) and was significantly associated with IA-2A positivity ($P < 0.001$). Among patients with T1DM, TPO-Abs and IA-2A levels showed a strong positive correlation ($r = 0.895$, $P < 0.001$). **Conclusion:** TPO-Abs positivity was detected in 30.0% of patients with T1DM and was significantly associated with IA-2A positivity. These findings suggest coexistence of thyroid and islet autoimmunity among patients with T1DM; however, large studies are needed to confirm this association.

Keywords: Type 1 diabetes mellitus; TPO-Abs; IA-2 autoantibodies; thyroid autoimmunity; islet autoimmunity.

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INTRODUCTION

Type 1 diabetes mellitus (T1DM) is a chronic autoimmune disease characterized by immune-mediated destruction of pancreatic beta cells, resulting in progressive insulin deficiency. Patients with T1DM are at increased risk of developing other organ-specific autoimmune conditions, supporting the concept of autoimmune clustering and the importance of appropriate screening and follow-up strategies (1–3).

Autoimmune thyroid disease is one of the most common autoimmune conditions associated with T1DM. Its coexistence with

T1DM is thought to be related to shared genetic susceptibility and overlapping immunological mechanisms, including susceptibility alleles within the human leukocyte antigen system and immune-regulatory genes (1,4,5).

Thyroid peroxidase antibodies (TPO-Abs) are important serological markers of thyroid autoimmunity in patients with T1DM. Their presence may help identify individuals with T1DM who are at increased risk of subsequent thyroid dysfunction. Previous longitudinal evidence has shown that TPO-Abs positivity at

the onset of T1DM is associated with an increased risk of future thyroid dysfunction (6).

Recent studies have suggested that thyroid autoimmunity may be more frequent among female patients with T1DM and that thyroid autoantibody positivity may be associated with specific islet autoantibodies. These findings support the importance of thyroid screening and periodic surveillance among patients with T1DM (7,8).

Islet autoantibodies are important markers of autoimmune diabetes and include antibodies directed against several pancreatic islet antigens, such as insulin, glutamic acid decarboxylase, zinc transporter 8, and insulinoma-associated protein 2. In individuals at risk of developing T1DM, islet autoantibodies may be detected before the onset of clinical disease and can contribute to disease staging and risk stratification. Recent evidence indicates that the number, type, order of appearance, and affinity of islet autoantibodies may improve prediction of progression to T1DM (9–11).

IA-2 autoantibodies (IA-2A) are important markers of islet autoimmunity and may assist in the characterization of autoimmune diabetes. The coexistence of IA-2A and thyroid autoantibodies may reflect the clustering of organ-specific autoimmune responses in genetically susceptible individuals. This autoimmune clustering provides a possible biological explanation for the coexistence of thyroid and islet autoimmunity among patients with T1DM (1,4,5).

Although the association between T1DM and autoimmune thyroid disease is well established, Iraqi evidence remains limited and varies between regions and study populations. This limitation makes it difficult to estimate the local burden of thyroid autoimmunity accurately and may restrict the development of locally appropriate screening and surveillance strategies (12–14).

Therefore, this study aimed to determine the prevalence of TPO-Abs positivity and

evaluate its association with IA-2A positivity and serum IA-2A levels among patients with T1DM in Al-Najaf Province, Iraq. By providing local evidence regarding the coexistence of thyroid and islet autoimmunity, this study may contribute to improved risk assessment and thyroid surveillance among patients with T1DM.

PATIENTS AND METHODS

Study Design and Study Population: A hospital-based analytical cross-sectional study was conducted at the Diabetes Center, Al-Sadr Medical City, Al-Najaf, Iraq, between September 2022 and May 2023. The study included 30 patients with T1DM and 20 apparently healthy volunteers as controls.

Inclusion Criteria:

1. Patients with T1DM.
2. Age between 10 and 50 years.
3. Both males and females.
4. Written informed consent from participants or parental consent for minors.

Exclusion Criteria:

1. Patients with T2DM.
2. Patients with previously diagnosed autoimmune thyroid disease or those receiving thyroid medication.
3. Patients with other autoimmune diseases.
4. Pregnant women.
5. Patients with acute infections or severe chronic systemic diseases.
6. Patients receiving immunosuppressive therapy.

Data Collection: Demographic data, including age and sex, were recorded for all participants. Venous blood samples were collected under aseptic conditions. Serum was separated by centrifugation and stored at -20°C until laboratory analysis.

Laboratory Investigations: Serum thyroid peroxidase antibodies were measured using an Anti-TPO ELISA (IgG) kit (Euroimmun, Germany) according to the manufacturer's instructions. Values <30 IU/mL were considered negative, whereas values ≥ 30 IU/mL

were considered positive (15). Serum IA-2 autoantibodies were measured using the RSR IA-2 Autoantibody ELISA Version 2 kit (RSR Ltd., Cardiff, UK) according to the manufacturer's instructions. The assay has a calibrator range of 7.5-4000 U/mL, with values <7.5 U/mL considered negative and values ≥ 7.5 U/mL considered positive (16).

Statistical analysis: Statistical analysis was performed using SPSS version 20. Continuous variables were expressed as mean $\pm$ standard error of the mean, and categorical variables as frequencies and percentages. Group comparisons were performed using the independent samples t-test and Fisher's exact test, as appropriate. Pearson's correlation coefficient was used to assess the relationship between TPO-Abs and IA-2 autoantibody level.

Ethical Approval: The study protocol was approved by the appropriate Institutional Ethics Committee. Written informed consent was obtained from all participants or their legal guardians before enrollment. All procedures were conducted in accordance with the principles of the Declaration of Helsinki.

RESULTS

Sociodemographic Characteristics: The study included 50 participants, 30 patients with T1DM and 20 apparently healthy controls. Overall, 25 participants were male and 25 were female, representing 50.0% for each sex. The participants' ages ranged from 10 to 50 years, with an overall mean age of 25.52 ± 1.56 years (Table 1).

Table 1: Distribution of the study sample according to socio-demographic characteristics (n=50).

Sociodemographic characteristic	Category	Number (n.)	(%)Percentage
Sex	Male	25	50.0
	Female	25	50.0
	Total	50	100.0
Age (year)	Range	10-50	–
	Mean $\pm$ SEM	25.52 ± 1.56	–

Comparison of Age Between Study Groups: The mean age was significantly higher among patients with T1DM than among healthy controls. The mean age was 28.83 ± 2.32 years

in the T1DM group and 20.55 ± 1.15 years in the control group. This difference was statistically significant ($t = 3.194$, $P = 0.003$) (Table 2).

Table 2: Comparison of mean age between patients with a Diabetes mellitus and healthy controls.

Study variable	Group	Number (n)	Mean	SEM	t-value	P-value
Age (years)	Diabetes mellitus	30	28.83	2.32	3.194	0.003*
	Control	20	20.55	1.15	–	–
*P value ≤ 0.05 was considered statistically significant.						

Distribution of Sex: The distribution of sex was identical in the two study groups. Males represented 50.0% of the T1DM group and 50.0% of the control group, while females

represented the remaining 50.0% in each group. No statistically significant association was observed between sex and study group ($\chi^2 = 0.00$, $P = 1.000$) (**Table 3**).

Table 3: Association between study group and sex.

Sex	Diabetes mellitus (%), n	Control (%), n	χ^2	P value
Males	15 (50.0)	10 (50.0)	0.00	1.000
Females	15 (50.0)	10 (50.0)	–	–
Total	30 (100.0)	20 (100.0)	–	–
P > 0.05 was considered not statistically significant				

Serum TPO-Abs and IA-2A Levels: Serum TPO-Abs levels were significantly higher among patients with T1DM than among healthy controls. The mean TPO-Abs level was (77.56 ± 30.26 IU/mL) in the T1DM group compared with (7.03 ± 0.84 IU/mL) in the control group ($t = 2.330$, $P = 0.027$).

Similarly, serum IA-2A levels were significantly higher among patients with T1DM than among healthy controls. The mean IA-2A level was (255.51 ± 118.43 U/mL) in the T1DM group compared with (4.92 ± 0.38 U/mL) in the control group ($t = 2.116$, $P = 0.043$) (**Table 4**).

Table 4: Comparison of mean serum TPO-Abs and IA-2A level between the study groups.

Study variable	Group	Number (n)	Mean	SEM	t-value	P-value
TPO (IU/mL)	Diabetes mellitus	30	77.56	30.26	2.330	0.027*
	Control	20	7.03	0.84	–	–
IA-2A (U/mL)	Diabetes mellitus	30	255.51	118.43	2.116	0.043*
	Control	20	4.92	0.38	–	–
*P ≤ 0.05 was considered statistically significant.						

Association Between TPO-Abs and IA-2A Positivity: A statistically significant association was observed between TPO-Abs positivity and IA-2A positivity in the total study sample ($P < 0.001$). Among the 41 participants with negative TPO-Abs results, all were negative for IA-2A.

In contrast, all 9 participants with positive TPO-Abs results were also positive for IA-2A. Overall, 9 of the 50 participants (18.0%) were positive for both antibodies, whereas 41 participants (82.0%) were negative for both antibodies (**Table 5**). Among the 30 patients

with T1DM, 9 were positive for TPO-Abs, corresponding to a TPO-Abs positivity rate of 30.0% in the patient group.

Table 5: Association between TPO-Abs and IA-2A positivity in the study sample.

TPO-Abs status	IA-2A negative <7.5 (U/mL), n(%)	IA-2A positive ≥7.5 (U/mL), n(%)	Total
Negative <30 (IU/mL)	41 (100.0)	0 (0.0)	41
Positive ≥30 (IU/mL)	0 (0.0)	9 (100.0)	9
Total	41 (82.0)	9 (18.0)	50
Fisher-exact test, P < 0.001*			

Correlation Between Serum TPO-Abs and IA-2A Levels: Among patients with T1DM, a strong positive correlation was observed between serum TPO-Abs and IA-2A levels.

This correlation was statistically significant ($r = 0.895$, $P < 0.001$; $n = 30$) (Table 6 and Figure 1).

Table 6. Pearson correlation between serum TPO-Ab and IA-2A levels among patients with type 1 diabetes mellitus

Variables	Number (n)	Pearson's correlation coefficient (r)	P-value
TPO-Abs and IA-2A	30	0.895	<0.001*
P ≤ 0.05 was considered statistically significant.*			

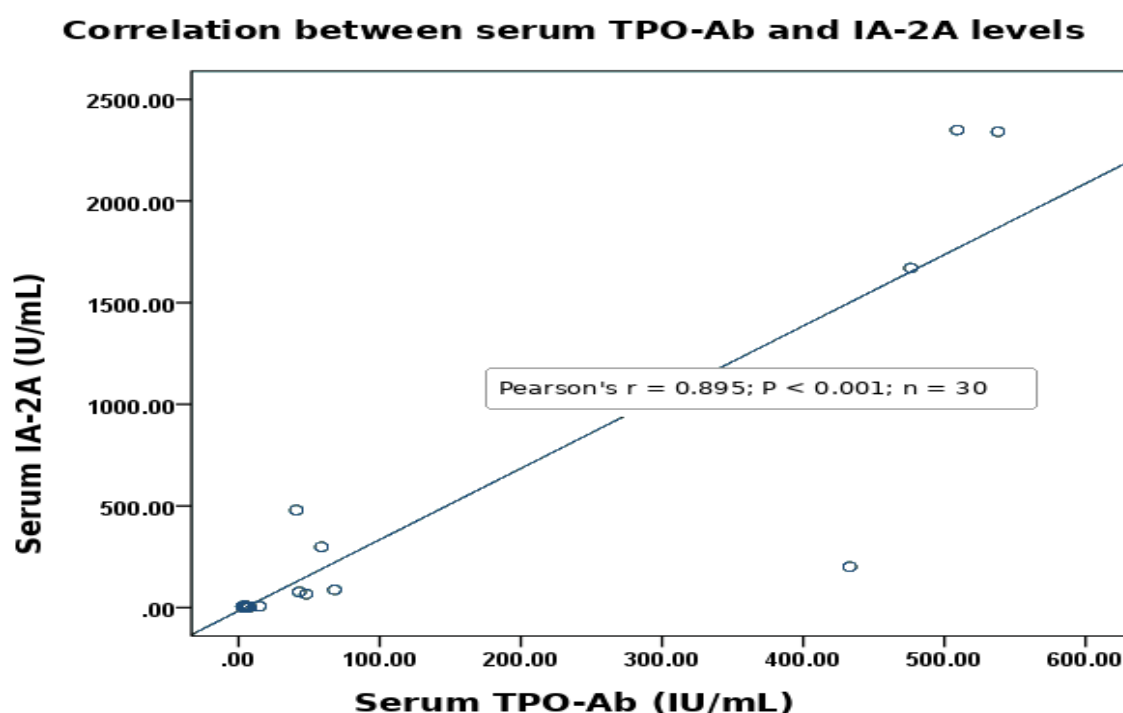


Figure 1: Scatter plot with positive linear regression showing correlation between serum TPO-Ab and IA-2A levels among patients with type 1 diabetes mellitus.

DISCUSSION

The present study demonstrated significantly higher serum TPO-Abs and IA-2A levels among patients with T1DM than among healthy controls. TPO-Abs positivity was also significantly associated with IA-2A positivity, and a strong positive correlation was observed between serum TPO-Abs and IA-2A levels among patients with T1DM. These findings suggest that thyroid and islet autoimmunity may coexist in patients with T1DM and are compatible with the concept of shared immunogenetic susceptibility (1,4,5).

In the present study, TPO-Abs positivity was detected in 9 of 30 patients with T1DM, corresponding to 30.0% of the patient group. This finding indicates that a considerable proportion of the studied patients had serological evidence of thyroid autoimmunity, despite the exclusion of participants with previously diagnosed autoimmune thyroid disease or those receiving thyroid medication. However, because thyroid function tests and thyroid ultrasonography were not evaluated,

TPO-Abs positivity should be interpreted as evidence of thyroid autoimmunity rather than a confirmed diagnosis of autoimmune thyroid disease.

The increased IA-2A levels observed among patients with T1DM are consistent with the presence of islet autoimmunity. IA-2A is an important marker associated with autoimmune diabetes and may assist in characterizing autoimmune heterogeneity and assessing the risk of disease progression (17–19). Nevertheless, IA-2A levels alone do not directly measure the extent or current activity of pancreatic beta-cell destruction; therefore, the present results should not be interpreted as evidence of active beta-cell destruction.

The significant association between TPO-Abs positivity and IA-2A positivity is biologically plausible. T1DM and autoimmune thyroid disease share several genetic and immunological susceptibility factors, including HLA class II alleles and immune-regulatory loci such as CTLA-4 and PTPN22. This shared susceptibility may facilitate the development of

multiple organ-specific autoantibodies and contribute to the coexistence of thyroid and islet autoimmunity (4,5,20,21).

The strong positive correlation between serum TPO-Abs and IA-2A levels among patients with T1DM further supports the possibility of a relationship between thyroid and islet autoimmunity. However, the cross-sectional design of the study does not establish a temporal or causal relationship between the two antibody responses. In addition, the correlation was calculated in a relatively small group of patients and should therefore be interpreted cautiously and confirmed in larger studies.

The findings of the present study are consistent with previous Iraqi and regional reports describing an increased frequency of thyroid or islet autoantibodies among patients with T1DM. These reports support the view that organ-specific autoimmune diseases may coexist in genetically susceptible individuals (8,12,13,22). However, differences in age distribution, sample size, disease duration, laboratory methods, antibody cut-off values, and patient selection may contribute to differences in the reported prevalence between studies.

The present findings are also consistent with the study by **Al Zuhairi and Hasan**, which reported a higher frequency of pancreatic islet autoantibodies, including IA-2A, among Iraqi patients with T1DM than among healthy controls. Their findings support the utility of IA-2A as a marker of islet autoimmunity in the Iraqi population and are consistent with the elevated IA-2A levels observed in the present study (22).

International evidence indicates that IA-2A positivity may be associated with an increased risk of progression through the stages of autoimmune diabetes. Accordingly, IA-2A may have value in disease classification, risk assessment, and characterization of disease heterogeneity in addition to its diagnostic role (10,17,23). However, the present study was cross-sectional and did not include longitudinal

follow-up; therefore, it cannot determine whether participants with higher IA-2A levels had a greater risk of future disease progression.

The coexistence of TPO-Abs and IA-2A positivity may reflect autoimmune clustering, whereby several organ-specific autoimmune responses develop in the same susceptible individual. Impaired immune tolerance and shared genetic susceptibility may contribute to the activation of autoreactive T cells and B cells directed against different endocrine tissues. This mechanism provides a plausible biological explanation for the association observed in the present study, although the specific immunological pathways could not be investigated using the current study design (1,4,5,21,24).

Our findings can also be considered in relation to the longitudinal study by **Carreras et al.**, which reported that thyroid autoantibody positivity at the onset of T1DM was associated with an increased risk of subsequent thyroid dysfunction during long-term follow-up (6). Although that study investigated the prognostic importance of thyroid autoimmunity, whereas the present study assessed antibody levels and their association at a single time point, both studies emphasize the clinical relevance of identifying TPO-Abs among patients with T1DM.

Similarly, previous studies by **Jia and Yu** and by **Kawasaki emphasized** the importance of islet autoantibodies, including IA-2A, in the characterization of autoimmune diabetes and the assessment of progression risk (11,19). The present findings extend these observations by demonstrating an association between IA-2A and TPO-Abs in patients with T1DM. Nevertheless, this association should not be interpreted as evidence that higher IA-2A levels directly cause thyroid autoimmunity.

Regional studies have also reported a considerable burden of thyroid autoimmunity among patients with T1DM. **Hazzaa et al.** reported a relatively high prevalence of

autoimmune thyroid disease among patients with T1DM in Syria and highlighted the possibility that thyroid autoimmunity may remain clinically silent. Similarly, **Mohammed and Ahmed** reported an association between T1DM and autoimmune diseases among pediatric patients in Erbil, supporting the coexistence of autoimmune conditions in susceptible individuals (8,12). Regarding Iraqi evidence, **Jabar et al.** reported significantly higher anti-TPO antibody levels among Iraqi patients with T1DM than among healthy controls, supporting the presence of thyroid autoimmunity in the Iraqi population (13). Although their study did not assess IA-2A, its findings are consistent with the increased TPO-Abs levels observed in the present study. **Al Zuhairi and Hasan** also reported increased pancreatic autoantibody frequencies, including IA-2A, among Iraqi patients with T1DM, supporting the relevance of islet autoantibody testing in the local population (22).

Previous reviews have emphasized that autoimmune thyroid disease is one of the most common autoimmune comorbidities among patients with T1DM and that thyroid assessment is clinically relevant in this population (25). In the present study, TPO-Abs positivity may indicate thyroid autoimmunity; however, thyroid function tests and ultrasonographic evaluation were not performed. Therefore, TPO-Abs positivity should not be interpreted as a confirmed diagnosis of autoimmune thyroid disease or as evidence of thyroid dysfunction. Further studies combining TPO-Abs measurement with thyroid function tests and ultrasonography are needed to clarify the clinical significance of thyroid autoimmunity among patients with T1DM.

Strengths and Limitations: The study provides preliminary local data regarding the relationship between TPO-Abs and IA-2A among patients with T1DM in Al-Najaf Province. The inclusion of a healthy control group and the assessment of both antibody

markers are strengths of the study. However, several limitations should be acknowledged. **First**, the sample size was small, which limits statistical power and the precision of prevalence estimates. **Second**, the study was conducted at a single medical center, which may limit the generalizability of the findings to the wider population of Al-Najaf or Iraq. **Third**, the patient and control groups differed significantly in age, which may have influenced the comparison of antibody levels.

Fourth, the study was cross-sectional and did not include follow-up; therefore, temporal or causal relationships between TPO-Abs and IA-2A cannot be established. **Fifth**, thyroid function tests and thyroid imaging were not performed, so TPO-Abs positivity could not be correlated with clinical thyroid dysfunction. **Finally**, additional islet autoantibodies, particularly GADA, ZnT8A, and IAA, were not measured.

CONCLUSION

The present study demonstrated significantly higher serum TPO-Abs and IA-2A levels among patients with T1DM than among healthy controls. TPO-Abs positivity was detected in 30.0% of the patients with T1DM and was significantly associated with IA-2A positivity. A strong positive correlation was also observed between serum TPO-Abs and IA-2A levels among patients with T1DM. These findings suggest the coexistence of thyroid and islet autoimmunity; however, the small sample size, cross-sectional design, age imbalance, and absence of thyroid function testing limit the strength and generalizability of the conclusions.

RECOMMENDATIONS

Screening for thyroid autoimmunity using TPO-Abs, together with periodic thyroid function assessment, may be considered among patients with T1DM. Larger multicenter studies with age-matched controls and longitudinal follow-up are needed to confirm the observed

association and determine its prognostic significance. Future studies should include thyroid function tests, thyroid ultrasonography, disease duration, and additional islet autoantibodies, particularly GADA, ZnT8A, and IAA, to provide a more comprehensive assessment of autoimmune heterogeneity in T1DM.

REFERENCES

1. Kahaly GJ, Forst T, Kellerer M, Lanzinger S, Rötzer RD, Schott M, *et al.* Type 1 diabetes and other autoimmune diseases: epidemiology, pathophysiology and screening. *Endocrinol Diabetes Metab.* **2026**;9(1):e70119.
2. Aamodt KI, Powers AC. The pathophysiology, presentation and classification of type 1 diabetes. *Diabetes Obes Metab.* **2025**;27(Suppl 6):15-27.
3. Hussain S, Tree T, Mathieu C, Klupa T, Tuomaala AK, de Wit M, *et al.* An international consensus on screening and monitoring early-stage type 1 diabetes: a roadmap to European implementation. *Diabetes Obes Metab.* **2026**;28(5):3535-3556.
4. Márquez A, Martín J. Genetic overlap between type 1 diabetes and other autoimmune diseases. *Semin Immunopathol.* **2022**;44(1):81-97.
5. Frommer L, Kahaly GJ. Type 1 diabetes and autoimmune thyroid disease: the genetic link. *Front Endocrinol (Lausanne).* **2021**;12:618213.
6. Carreras G, *et al.* Thyroid autoimmunity at onset of type 1 diabetes as a predictor of thyroid dysfunction: a thirty-years retrospective longitudinal study. *Front Endocrinol (Lausanne).* **2025**;16:1699111.
7. Zhu Y, Yang H, Hu C, Qiao L, Li C, Hu S, *et al.* Thyroid autoimmunity in relation to islet autoantibodies in newly diagnosed type 1 diabetes mellitus in children and adolescents. *Front Endocrinol (Lausanne).* **2026**;17:1822960.
8. Hazzaa AA, Alsultan M, Kabalan Y, Alourfi Z. Autoimmune thyroid disease in patients with type 1 diabetes mellitus: a cross-sectional study from Syria. *Medicine (Baltimore).* **2024**;103(4):e36107.
9. Khine A, Quandt Z. From prediction to prevention: the intricacies of islet autoantibodies in type 1 diabetes. *Curr Diab Rep.* **2025**;25(1):38.
10. Felton JL, Redondo MJ, Oram RA, Speake C, Long SA, Onengut-Gumuscu S, *et al.* Islet autoantibodies as precision diagnostic tools to characterize heterogeneity in type 1 diabetes: a systematic review. *Commun Med (Lond).* **2024**;4(1):66.
11. Jia X, Yu L. Understanding islet autoantibodies in prediction of type 1 diabetes. *J Endocr Soc.* **2024**;8(1):bvad160.
12. Mohammed LA, Ahmed YB. Correlation between autoimmune diseases and type 1 diabetes mellitus in the pediatric age group in Erbil city. *Zanco J Med Sci.* **2024**;28(1):85-94.
13. Jabar SS, Mohammed SB, Mahdi AR. Level and statistical distribution of thyroid peroxidase and thyroid hormones in Iraqi patients with type 1 diabetes mellitus at Al-Karkh side. *Baghdad Sci J.* **2016**;13(2):Article 15.
14. Ridha MF, Al Zubaidi MA. Thyroid autoimmune antibodies in children with type 1 diabetes mellitus in relation to diabetes control. *Pak J Med Sci.* **2019**;35(4):969-973.
15. EUROIMMUN Medizinische Labordiagnostika AG. Anti-TPO ELISA (IgG). Lübeck, Germany: EUROIMMUN Medizinische Labordiagnostika AG.
16. RSR Ltd. ElisaRSR IA-2 Ab Version 2: IA-2 Autoantibody ELISA Version 2. Instructions for use. Cardiff, United Kingdom: RSR Ltd.
17. Sims EK, Cuthbertson D, Ferrat LA, Bosi E, *et al.* IA-2A positivity increases risk of progression within and across established stages of type 1 diabetes. *Diabetologia.* **2025**;68(5):993-1004.
18. Mauvais FX, van Endert PM. Type 1 diabetes: a guide to autoimmune mechanisms

for clinicians. *Diabetes Obes Metab.* **2025**;27(Suppl 6):40-56.

19. Kawasaki E. Anti-islet autoantibodies in type 1 diabetes. *Int J Mol Sci.* **2023**;24(12):10012.

20. Kahles H, Fain PR, Baker P, Eisenbarth GS, *et al.* Genetics of autoimmune thyroiditis in type 1 diabetes reveals a novel association with DPB1*0201: data from the Type 1 Diabetes Genetics Consortium. *Diabetes Care.* **2015**;38(Suppl 2):S21-S28.

21. Huber A, Menconi F, Corathers S, Jacobson EM, Tomer Y. Joint genetic susceptibility to type 1 diabetes and autoimmune thyroiditis: from epidemiology to mechanisms. *Endocr Rev.* **2008**;29(6):697-725.

22. Al Zuhairi RAH, Hasan AA. Autoantibodies as predictive markers in type 1 diabetes: insights from Iraqi patients. *Al-*

Wataniya J Med Sci. **2025**;1(2):38-48.

23. Sosenko JM, Skyler JS, Palmer JP, Krischer JP, Cuthbertson D, Yu L, *et al.* A longitudinal study of GAD65 and ICA512 autoantibodies during the progression to type 1 diabetes in Diabetes Prevention Trial-Type 1 (DPT-1) participants. *Diabetes Care.* **2011**;34(11):2435-2437.

24. Negrato CA, Pereira RZ, Porto LDMP, Santana YWS, Sato AKI, Melo VC, *et al.* Prevalence of autoimmune diseases in patients with type 1 diabetes: a scoping review. *Einstein (Sao Paulo).* **2025**;23:eRW1222.

25. Wang J, Wan K, Chang X, Mao RF. Association of autoimmune thyroid disease with type 1 diabetes mellitus and its ultrasonic diagnosis and management. *World J Diabetes.* **2024**;15(3):348-360.