




Clinical Spectrum and Autoimmune Profiles in a Libyan Clinical Cohort with Thyroid Disorders: A Pilot Study from Bani Waleed, Libya

Samira Daw Ameigal¹ Assaaih Matoug Alhameri² Eman Otman Masood¹ Maha Younes Aboseta¹
Alaa Ali Masoud¹ Najib Mohamed Eljabu³ Yahia Khalid Bahri⁴ Mariam Abdalgader Gremeda⁴
Marwa SaedAli Emhemed⁵

¹ Department of Medical Laboratories, Higher Institute of Medical and Sciences Technologies, Bani Waleed, Libya

² Department of Medical Laboratories, Faculty of Medical Technology, Aljufra University, Aljufra, Libya

³ Department of Medical Laboratories, Faculty of Medical Technology Misurata, Libya

⁴ Alyaqeen Medical Laboratory, Private Medical Laboratory, Bani Waleed, Libya

⁵ Faculty of Medicine, University of Tripoli, Tripoli, Libya

Address for correspondence Samira Daw Ameigal, MD, Department of Medical Laboratories, Higher Institute of Medical and Sciences Technologies, Bani Waleed, Libya (e-mail: emeigalsamira@gmail.com).

Libyan Int Medical Univ J

Abstract

Background Despite being one of the largest countries in North Africa, Libya lacks sufficient data on the frequencies of thyroid diseases and autoimmune thyroid disorders (AITDs), particularly Hashimoto's thyroiditis and Graves' disease.

Aim This study aimed to investigate the frequency and patterns of thyroid dysfunction and autoimmune markers in a clinical cohort of patients with thyroid disorders.

Methods In this pilot cross-sectional study, 130 patients with thyroid disorders were recruited between March and September 2023. Children and pregnant women were excluded. Demographic data, including sex, age, weight, height, family history, hypertension, diabetes mellitus, and type of thyroid medication, were collected via a questionnaire. Blood samples were also obtained from all subjects to measure thyroid hormones (T3 [nmol/L], T4 [nmol/L], and thyroid-stimulating hormone [TSH] [μ IU/mL]) and thyroid antibodies (antithyroid peroxidase [anti-TPO] and anti-thyroglobulin [anti-TG] levels). Anti-TPO \geq 40 IU/mL and anti-TG \geq 104 ng/mL were defined as positive. Data analysis (SPSS v23) employed descriptive statistics, comparative tests (*t*-tests, analysis of variance, chi-square), and binary logistic regression to identify predictors of autoimmunity. A *p*-value of < 0.05 was considered significant.

Results The participants consisted of 108 females (83.1%) and 22 males (16.9%), with a mean age of 42.41 ± 14.44 years (range, 18–70 years). The percentage of overt hypothyroidism and subclinical hypothyroidism was 35.4% (46/130) and 13.1% (17/130), respectively. The proportion of overt hyperthyroidism and subclinical hyperthyroidism was 9.2% (12/130) and 5.4% (7/130), respectively. Additionally, treated hypothyroidism was observed in 30.8% (40/130) and treated hyperthyroidism

Keywords

- ▶ thyroid disorders
- ▶ autoimmune thyroid diseases
- ▶ cross-sectional study
- ▶ anti-TPO
- ▶ anti-TG
- ▶ Libya

Dates of submission

July 17, 2025

revision

October 20, 2025

acceptance

December 19, 2025

DOI <https://doi.org/>

10.1055/s-0046-1815919.

ISSN 2519-139X.

© 2026. The Author(s).

This is an open access article published by Thieme under the terms of the Creative Commons Attribution License, permitting unrestricted use, distribution, and reproduction so long as the original work is properly cited. (<https://creativecommons.org/licenses/by/4.0/>)

Thieme Medical and Scientific Publishers Pvt. Ltd., A-12, 2nd Floor, Sector 2, Noida-201301 UP, India

in 6.2% (8/130) of the participants. The mean and standard deviations of TSH, T3, and T4 were $7.51 \pm 15.11 \mu\text{U/mL}$, $4.90 \pm 28.33 \text{ nmol/L}$, and $90.29 \pm 86.26 \text{ nmol/L}$, respectively. The overall frequency of AITDs was 49.2% (64/130) of our sample. Specifically, the frequency of positive anti-TPO and anti-TG antibodies was 43.1% (56/130) and 22.3% (29/130), respectively, with 12.3% (16/130) of the patients testing positive for both antibodies. Body mass index showed a significant association with thyroid disorders ($p = 0.014$) and with anti-TPO positivity ($p = 0.03$). Positive anti-TG antibodies were significantly more frequent in females ($p = 0.01$).

Conclusion This pilot study highlights a high frequency of thyroid dysfunction and autoimmunity among patients presenting for routine investigations in private clinics. While the findings are not generalizable to the wider Libyan population due to sample size and selection bias, they emphasize the importance of routine thyroid antibody testing and provide groundwork for larger, population-based studies.

ملخص المقال باللغة العربية

الطيف السريري والمفلات المناعية الذاتية في مجموعة سريرية ليبية مصابة باضطرابات الغدة الدرقية: دراسة استطلاعية من بني وليد، ليبيا

المؤلفون: سميرة ضو أمعيل، السايح معنوق، ايمان عثمان، مها يونس، ألاء علي، نجيب محمد، يحي خالد، مريم عبد القادر، مروة سعيد، قسم المختبرات الطبية، المعهد العالي للعلوم والتقنيات الطبية، بني وليد، ليبيا.

المؤلف المسؤول: سميرة ضو أمعيل، البريد الإلكتروني: emeigalsamira@gmail.com

الخلفية: تفتقر ليبيا إلى بيانات كافية عن معدلات أمراض الغدة الدرقية واضطرابات الغدة الدرقية المناعية الذاتية. وخاصة التهاب الغدة الدرقية لهاشيموتو ومرض جريفز. **الهدف:** هدفت هذه الدراسة إلى التحقق من معدل وأنماط خلل وظيفة الغدة الدرقية والعوامل المناعية الذاتية في مجموعة من المرضى المصابين باضطرابات الغدة الدرقية والذين يراجعون للفحوصات الروتينية في عيادة خاصة في مدينة بني وليد.

الطرق: في هذه الدراسة الاستطلاعية المقطعية، تم استخدام 130 مريضاً مصاباً باضطرابات الغدة الدرقية بين مارس وسبتمبر 2023. تم استبعاد الأطفال والنساء الحوامل. تم جمع البيانات الديموغرافية عن طريق استبيان يشمل الجنس والعمر والوزن والطول والتاريخ العائلي وارتفاع ضغط الدم ومرض السكري ونوع دواء الغدة الدرقية. في نفس الوقت تم أخذ عينات دم من جميع المشاركين لقياس مستويات هرمونات الغدة الدرقية (هرمون ثلاثي يود الثيرونين، هرمون رباعي يود الثيرونين والهرمون منبه الدرقية). كما تم قياس مستوى أجسامها المضادة (الأجسام المضادة لبيروكسيداز الغدة الدرقية [Anti-TPO] والأجسام المضادة للثيروغلوبولين [anti-TG]). أعتبر تركيز الأجسام المضادة لبيروكسيداز الدرقية الأكثر من 40 وحدة دولية/مل وكذلك الأجسام المضادة للثيروغلوبولين الأكثر من 104 نانوجرام/مل إيجابية. استخدم في تحليل البيانات (SPSS الإصدار 23) للإحصاء الوصفي. والاختبارات المقارنة (اختبارات t، ANOVA، ومرجع كاي)، والانحدار اللوجستي الثنائي لتحديد العوامل المتنبئة بالمناعة الذاتية. اعتبرت قيمة $p < 0.05$ ذات دلالة إحصائية.

النتائج: تكون المشاركون من 108 إناث (83.1%) و22 ذكراً (16.9%)، بمتوسط عمر 42.41 ± 14.44 سنة (المدى 18-70 سنة). كانت نسبة قصور الغدة الدرقية الصريح 35.4% (46/130) وتحت السريري 13.1% (17/130). وكانت نسبة فرط نشاط الغدة الدرقية الصريح 9.2% (12/130) وتحت السريري 5.4% (7/130). بالإضافة إلى ذلك، لوحظ قصور الغدة الدرقية المعالج في 30.8% (40/130) وفرط نشاط الغدة الدرقية المعالج في 6.2% (8/130) من المشاركين. وكان متوسط هرمون منبه الدرقية 7.5 ± 15.11 ميكرو وحدة دولية/مل، وهرمون ثلاثي يود الثيرونين 4.9 ± 28.3 نومول/لتر وهرمون رباعي يود الثيرونين 90.29 ± 86.26 نومول/لتر. بلغ التكرار الإجمالي لاضطرابات الغدة الدرقية المناعية الذاتية 49.2% (64/130) من عينتنا. على وجه التحديد، كان تواتر الأجسام المضادة الإيجابية لـ الأجسام المضادة لبيروكسيداز الدرقية 43.1% (56/130) والأجسام المضادة للثيروغلوبولين 22.3% (29/130). مع وجود 12.3% (16/130) من المرضى إيجابيين لكلا الجسمين المضادين. أظهر مؤشر كتلة الجسم ارتباطاً ذا دلالة إحصائية مع اضطرابات الغدة الدرقية ($p = 0.014$) وكذلك علاقة إيجابية مع الأجسام المضادة لبيروكسيداز الدرقية ($p = 0.03$). كانت الأجسام المضادة الإيجابية لـ الأجسام المضادة للثيروغلوبولين (Anti-TG) أكثر تكراراً بشكل ملحوظ لدى الإناث ($p = 0.01$).

الاستنتاج: تسلط هذه الدراسة الاستطلاعية الضوء على ارتفاع معدل خلل وظيفة الغدة الدرقية والمناعة الذاتية بين المرضى الذين يخضعون للفحوصات الروتينية في العيادات الخاصة. بينما لا يمكن تعميم النتائج على عموم السكان اللبيين بسبب حجم العينة وتحيز الاختيار، فإنها تؤكد على أهمية الفحص الروتيني لأجسام الغدة الدرقية المضادة وتوفر أساساً لدراسات أوسع قائمة على السكان.

الكلمات المفتاحية: اضطرابات الغدة الدرقية، أمراض الغدة الدرقية المناعية الذاتية، دراسة مقطعية، الأجسام المضادة لبيروكسيداز الدرقية (Anti-TPO)، الأجسام المضادة للثيروغلوبولين (Anti-TG)، ليبيا

Introduction

The thyroid gland plays a pivotal role in endocrine regulation by producing two significant hormones, thyroxine (T4) and triiodothyronine (T3), which are critical for metabolism and growth.¹ Disruption of these hormones can lead to various thyroid disorders, including common thyroid dysfunctions such as goiter, nodules, and autoimmune thyroid diseases (AITDs). The development of thyroid diseases is influenced

by genetic and environmental factors, including iodine deficiency, sex, age, ethnicity, and autoantibodies.²⁻⁴ Two major autoantibodies (anti-thyroglobulin [anti-TG] and anti-thyroid peroxidase [anti-TPO]) affect the thyroid gland, leading to AITD.⁵ These antibodies are detected in 90 to 95% and 70 to 80% of AITD patients, respectively.⁶

Globally, the prevalence of thyroid dysfunction is becoming more common, and represents about 30 to 40% of

endocrine patients.⁷ Thyroid dysfunctions, particularly subclinical and overt hypothyroidism, have been associated with an increased risk of cardiovascular disease. Numerous studies have highlighted the morbidity linked to thyroid dysfunction.^{8,9}

AITD is defined by the synthesis of antibodies to thyroid antigens and the infiltration of the thyroid gland by autoreactive lymphocytes.¹⁰ AITD is the most prevalent autoimmune disorder, affecting an estimated 2 to 5% of the global population.¹¹ The most common AITDs are Graves' disease (GD) and Hashimoto's thyroiditis (HT). GD is the leading cause of hyperthyroidism and thyrotoxicosis worldwide, while HT remains the most common cause of hypothyroidism in iodine-sufficient regions.¹²

HT is a chronic lymphocytic thyroiditis described by Hakaru Hashimoto in 1912. The disease develops by interaction between T helper cells, which include B lymphocytes and cytotoxic T cells targeting thyrocytes, leading to the death of thyrocytes and hypothyroidism.¹³ In GD, the thyroid-stimulating hormone (TSH) receptor is the primary autoantigen, secreted by B lymphocytes after induction by CD4 T cells, resulting in uncontrolled thyroid hormone production and hyperthyroidism.¹¹

A systematic review by McGrogan et al reported the incidence of AITD over the past two decades, revealing that the incidence of autoimmune hypothyroidism was approximately 80 and 350 per 100,000 per year for males and females, respectively. The rate of autoimmune hyperthyroidism was around 8/100,000/year in males and 80/100,000/year in females.¹⁴ Females are at significantly higher risk compared with males (~4–10 females for every male), with the frequency of AITD increasing with age (mean age 57 years). The incidence also varies by race and geographic region.¹⁵ HT is the most prevalent AITD globally, with an increasing incidence over recent decades,¹⁶ whereas GD is less common than HT.¹⁷

A review study published in 2011 on the prevalence of thyroid diseases in Africa found that GD is predominant, and the prevalence of AITD varies among African countries, with rates of 9.9% in Tunisia, 1.2% in Ethiopia, and 32.2% for HT. However, the prevalence of AITD remains unknown in many countries and is still underreported.¹⁸

In Libya, data on the prevalence of AITD among the Libyan population is sparse, with only a few studies conducted on this topic. A previous study by Ghawil et al aimed to determine the prevalence of thyroid antibodies among children with type 1 diabetes, reporting that the prevalence of anti-TPO and anti-TG was 23.4 and 7.8%, respectively.¹⁹

The etiology of AITD is not completely understood, but it is believed to result from a combination of genetic and environmental factors leading to the breakdown of immune tolerance and the development of AITD.²⁰ Epidemiological data suggest an interaction between these factors, with several genes and environmental influences—such as iodine, radiation, infection, smoking, stress, and certain drugs—being associated with the presence of thyroid antibodies.^{21–25}

This study was designed to assess the frequency and clinical patterns of thyroid dysfunction and autoimmune markers in a

cohort of patients presenting for routine investigations at private clinics in Bani Waleed city. Although the current study is a pilot to investigate the frequency of thyroid disorders, the findings underscore the clinical relevance of incorporating thyroid antibody testing into routine assessments. Moreover, they provide a preliminary foundation for future large-scale, population-based studies aimed at accurately characterizing the epidemiology of thyroid disorders in Libya.

Methods

Study Design and Setting

This pilot cross-sectional study was conducted between March and September 2023 in four private medical laboratories in Bani Waleed City, Libya (Al-Yaqeen Laboratory, Ibn-Sina Laboratory, Ogba Laboratory, and Aldahra Laboratory). The study protocol conformed to the ethical standards of the Declaration of Helsinki and was approved from the Bioethics Committee of the Biotechnology Research Center (BEC-BTRC, Tripoli, Libya). Written informed consent was obtained from all participants before enrollment.

Patient Selection and Recruitment

During the study period, 130 consecutive patients who were clinically diagnosed with thyroid disorders were recruited. Inclusion criteria required age ≥ 18 years, a confirmed diagnosis of thyroid dysfunction based on laboratory and/or clinical evaluation, and provision of informed written consent. Exclusion criteria included children (< 18 years), pregnant women, and patients with incomplete demographic or laboratory records. The final cohort, therefore, consisted of 130 adult patients with confirmed thyroid disorders, representing a consecutive convenience sample drawn from individuals presenting for routine diagnostic evaluations in private clinical settings.

Data Collection and Laboratory Analysis

The study employed a structured questionnaire to gather demographic data, including sex, age, weight, height, type of thyroid treatments, family history, and the presence of chronic diseases such as hypertension and diabetes mellitus. Venous blood samples were collected from all 130 participants to measure thyroid hormones (T3, T4, and TSH) and thyroid antibodies (anti-TPO and anti-TG). The serum samples were analyzed using electrochemiluminescence immunoassay reagent kits on the MAGLUMI chemiluminescence immunoassay fully automated analyzer (SNIBE). Reference ranges for TSH, TT3, and TT4 were determined according to the SNIBE kit. Anti-TPO Ab and anti-TG levels were measured using an enzyme immunoassay (SNIBE kit). Anti-TPO levels ≥ 40 IU/mL and anti-TG levels ≥ 104 ng/mL were defined as positive, based on the manufacturer's recommendations.

Data Analysis

Participants with thyroid disorders were classified into six groups based on their serum TSH, T3, and T4 levels: overt hypothyroidism, subclinical hypothyroidism, overt hyperthyroidism, subclinical hyperthyroidism, treated hypothyroidism

(levothyroxine), and treated hyperthyroidism (carbimazole). High TSH was defined as a concentration $> 4.0 \mu\text{IU/mL}$, and low TSH as a value $< 0.4 \mu\text{IU/mL}$. High T3 was defined as a concentration $> 3.08 \text{ nmol/L}$, and low T3 as $< 1.23 \text{ nmol/L}$. High T4 was defined as a concentration $> 150.6 \text{ nmol/L}$, and low T4 as $< 57.9 \text{ nmol/L}$. AITD was identified by the presence of positive anti-TPO and/or anti-TG Abs.

The etiology of autoimmune hypothyroidism (HT) was suggested by the presence of a high titer of anti-TPO and/or anti-TG Abs, along with a high TSH level (for overt/subclinical) or the use of levothyroxine (for treated). The etiology of autoimmune hyperthyroidism (GD) was suggested by the presence of positive anti-TPO and/or anti-TG Abs, along with a low TSH level (for overt/subclinical) or the use of carbimazole (for treated).

Height and weight were measured to compute body mass index (BMI), using the formula weight (kg) divided by height squared (m^2). BMI reference values were categorized as follows: underweight (< 18), average weight (18–25), overweight (26–30), and obese (> 30).

Statistical Analysis

Data analysis was performed with SPSS software (version 23, Statistical Package for the Social Sciences, SPSS Inc., Chicago, Illinois, United States). The mean and standard deviation (SD) were calculated for all parameters. The significance of the mean differences was analyzed using the independent *t*-test and one-way analysis of variance. Categorical data were presented as numbers and percentages and compared using chi-squared tests. The results were evaluated based on the distribution of basic characteristics such as age, height, weight, gender, and family history of disorders. Differences were considered statistically significant when the *p*-value was < 0.05 .

Results

This cross-sectional study included 130 patients diagnosed with thyroid dysfunction. The cohort was predominantly female 108 (83.1%), and 22 (16.9%) were males, indicating that thyroid dysfunction was approximately six times more common in females than males. The patients' ages ranged from 18 to 70 years, with a mean age of 42.41 ± 14.44 years. The largest proportion of participants (27.7%) was in the 30- to 39-year age group. The mean BMI of the study participants was $28.59 \pm 6.06 \text{ kg/m}^2$, with 72.3% of participants classified as overweight or obese. ►Table 1 summarizes the socio-demographic data of the study population.

The mean and SD of TSH, T3, and T4 were $7.51 \pm 15.11 \mu\text{IU/mL}$, $4.90 \pm 28.33 \text{ nmol/L}$, and $90.29 \pm 86.26 \text{ nmol/L}$, respectively. Based on reference classifications, 46 (35.4%, 95% confidence interval [CI]: 27.3–44.2%) participants had overt hypothyroidism, followed by treated hypothyroidism 40 (30.8%, 95% CI: 23.1–39.4%). The frequency of subclinical hypothyroidism, overt hyperthyroidism, subclinical hyperthyroidism, and treated hyperthyroidism were 17 (13.1%, 95% CI: 7.8–20.2%), 12 (9.2%, 95% CI: 4.8–15.6%), 7 (5.4%, 95% CI: 2.2–10.8%), and 8 (6.2%, 95% CI: 2.7–11.8%), respectively, as illustrated in ►Table 2.

Table 1 Sociodemographic characteristics of the study participants

Variable	N	%
Sex		
Male	22	16.9
Female	108	83.1
Age, mean SD	42.41 ± 14.44	16.9
18–29	22	27.7
30–39	36	26.2
40–49	34	15.4
50–59	20	13.8
≥ 60	18	
Family history of thyroid disorder		
Yes	76	58.5
No	54	41.5
BMI, mean SD	28.59 ± 6.06	2.3
Underweight	3	25.4
Normal weight	33	37.7
Overweight	49	34.6
Obese	45	
Medicine type		
Levothyroxine	106	81.5
Carbimazole	19	14.6
Non-take	5	3.9
Chronic disease		
Diabetes mellitus (DM)	15	11.5
Hypertension	5	3.9
Both (DM, hypertension)	8	6.2
Heart disease	2	1.5
Non	100	76.9
Previous diagnosed with thyroid dysfunction		
Yes	121	93.1
No	9	6.9
Smoking		
Smoker	6	4.6
Nonsmoker	124	95.4

Abbreviations: BMI, body mass index; SD, standard deviation.

The association between thyroid disorders and sociodemographic data was analyzed. The results revealed a statistically significant association between BMI and thyroid disorders, with a *p*-value of 0.014. The *p*-values for other variables were as follows: sex ($p = 0.342$), age ($p = 0.122$), family history ($p = 0.953$), chronic diseases ($p = 0.160$), medication use ($p = 0.000$), previous diagnosis ($p = 0.113$), and smoking ($p = 0.722$).

The overall frequency of AITD in our sample was 64/130 (49.2%, 95% CI: 40.8–57.7%), with subjects testing positive for anti-TPO, anti-TG, or both. The frequency of patients with positive anti-TPO Ab was 56/130 (43.1%, 95% CI: 34.9–51.7%), while 29/130 (22.3%, 95% CI: 16.0–30.2%) tested positive for anti-TG Ab. Additionally, 12.3% (16/130) of patients were positive for both anti-TPO and anti-TG Abs. The mean levels of anti-TPO and anti-TG were 313.77 ± 414.90 and $61.97 \pm 136.68 \text{ IU/L}$, respectively. The results also indicated that the frequency of HT was 49/130 (37.7%, 95% CI: 29.4–46.6%), while GD was found in 15/130 (11.5%, 95% CI: 6.5–

Table 2 The mean of TSH, T3, and T4 among participants

Thyroid disorder	Total, n %	95% CI	TSH	T3 (nmol/L)	T4 (nmol/L)
Overt hypothyroidism	46 (35.38)	27.3–44.2%	12.10 ± 16.76	1.93 ± 0.66	30.84 ± 34.20
Subclinical hypothyroidism	17 (13.1)	7.8–20.2%	17.87 ± 25.18	1.81 ± 0.62	90.29 ± 44.33
Overt hyperthyroidism	12 (9.23)	4.8–15.6%	0.27 ± 0.40	5.12 ± 1.21	211.10 ± 91.40
Subclinical hyperthyroidism	7 (5.38)	2.2–10.8%	1.81 ± 2.48	1.37 ± 0.59	68.39 ± 45.47
Treated hypothyroidism	40 (30.76)	23.1–39.4%	2.06 ± 0.85	1.45 ± 0.53	61.69 ± 44.01
Treated hyperthyroidism	8 (6.15)	2.7–11.8%	2.27 ± 1.11	2.54 ± 3.67	34.05 ± 39.01

Abbreviations: CI, confidence interval; T3, triiodothyronine; T4, thyroxin; TSH, thyroid-stimulating hormone.

18.4%) of the study population. The association between participants' autoimmune thyroid disorders and sociodemographic characteristics is illustrated in ►Table 3.

The proportion of participants with positive TPO Ab varied across different thyroid disorder groups in our sample: 16 (34.8%) in the overt hypothyroidism group, 11 (64.7%) in the subclinical hypothyroidism group, 4 (33.3%) in the overt hyperthyroidism group, 4 (57.1%) in the subclinical hyperthyroidism group, 18 (45.0%) in the treated hypothyroidism group, and 3 (37.5%) in the treated hyperthyroidism group, as illustrated in ►Fig. 1.

For participants with detectable TG Ab, the proportions were as follows: 7 (15.2%) in the overt hypothyroidism group, 6 (35.3%) in the subclinical hypothyroidism group, 8 (20.0%) in the treated hypothyroidism group, 5 (41.7%) in the overt hyperthyroidism group, 2 (28.6%) in the subclinical hyperthyroidism group, and 1 (12.5%) in the treated hyperthyroidism group, as illustrated in ►Fig. 2.

The proportion of positive TPO Ab in males and females was 8 (14.3%) and 48 (85.7%), respectively ($p = 0.352$), with an odds ratio (OR) of 1.40 (CI = 0.54–3.61). The prevalence of positive TG Ab in males and females was 1 (3.4%) and 28

Table 3 Sociodemographic characteristics of studies patients according to autoimmune status

Variables	Autoimmune status		p-Value
	Yes N = 64	No N = 66	
Sex			0.185
Male	8 (36.4%)	14 (63.6%)	
Female	56 (51.9%)	52 (48.1%)	
Age			0.060
18–29	12 (54.5%)	10 (45.5%)	
30–39	18 (50.0%)	18 (50.0%)	
40–49	16 (47.1%)	18 (52.9%)	
50–59	14 (70.0%)	6 (30.0%)	
≥ 60	4 (22.2%)	14 (77.8%)	
Family history			0.882
Yes	37 (48.7%)	39 (51.3%)	
No	27 (50.0%)	27 (50.0%)	
BMI kg/m ² , mean SD			0.290
Underweight	1 (50.0%)	1 (50.0%)	
Normal weight	18 (38.3%)	29 (61.7%)	
Overweight	19 (52.8%)	17 (47.2%)	
Obese	26 (57.8%)	19 (42.2%)	
Chronic disease			0.215
Diabetes mellitus (DM)	10 (66.7%)	5 (33.3%)	
Hypertension	4 (80.0%)	1 (20.0%)	
Both (DM + hypertension)	2 (25.0%)	6 (75.0%)	
Heart disease	1 (50.0%)	1 (50.0%)	
Non	47 (47.0%)	53 (53.0%)	
Smoking			0.439
Smoker	2 (33.3%)	4 (66.7%)	
Nonsmoker	62 (50.0%)	62 (50.0%)	

Abbreviations: BMI, body mass index; SD, standard deviation.

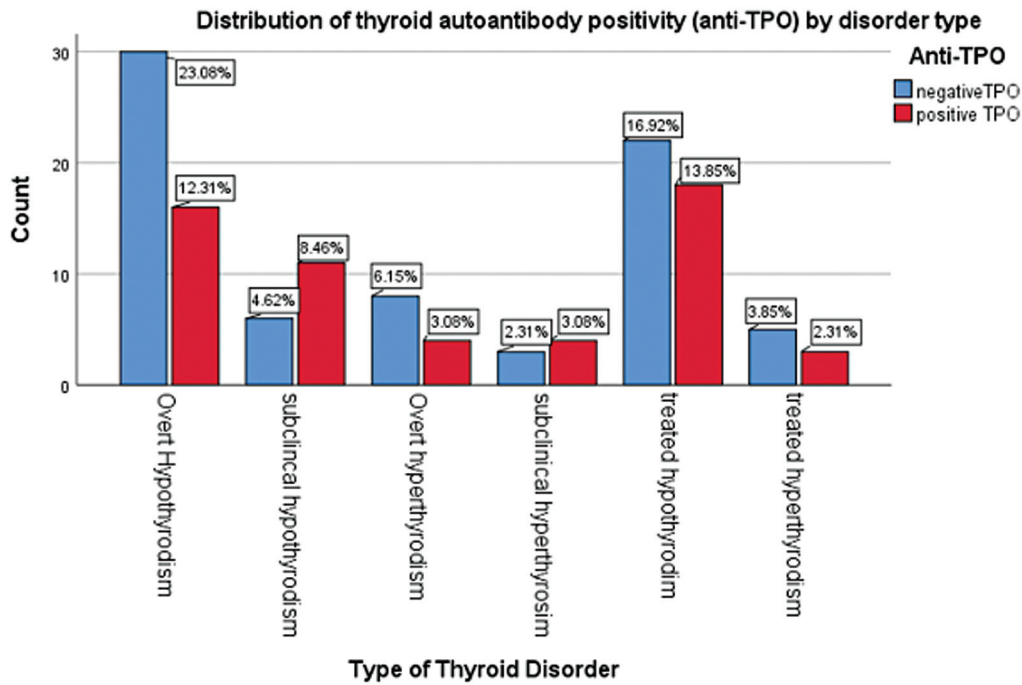


Fig. 1 Distribution of thyroid autoantibody positivity (anti-thyroid peroxidase [TPO]) by disorder type.

(96.6%), respectively ($p = 0.01$), with an OR of 7.35 (CI = 0.94–57.19).

Binary logistic regression was used to assess the correlation between individual factors and the levels of TPO Ab and TG Ab. The factors of sex, age, and BMI were evaluated. The results showed a significant correlation between BMI and TPO Ab levels (CI = 1.02–1.38, $p = 0.03$). The OR for age in subjects with TPO Ab was 6.41 (CI = 0.80–51.14, $p = 0.08$).

The OR for sex in subjects with TG Ab was 7.76 (CI = 0.98–61.57, $p = 0.02$), as illustrated in **Table 4**.

Discussion

In Libya, there is a lack of data regarding the prevalence of thyroid dysfunctions and autoimmune thyroid disorders in adult patients with thyroid disease. This pilot cross-sectional

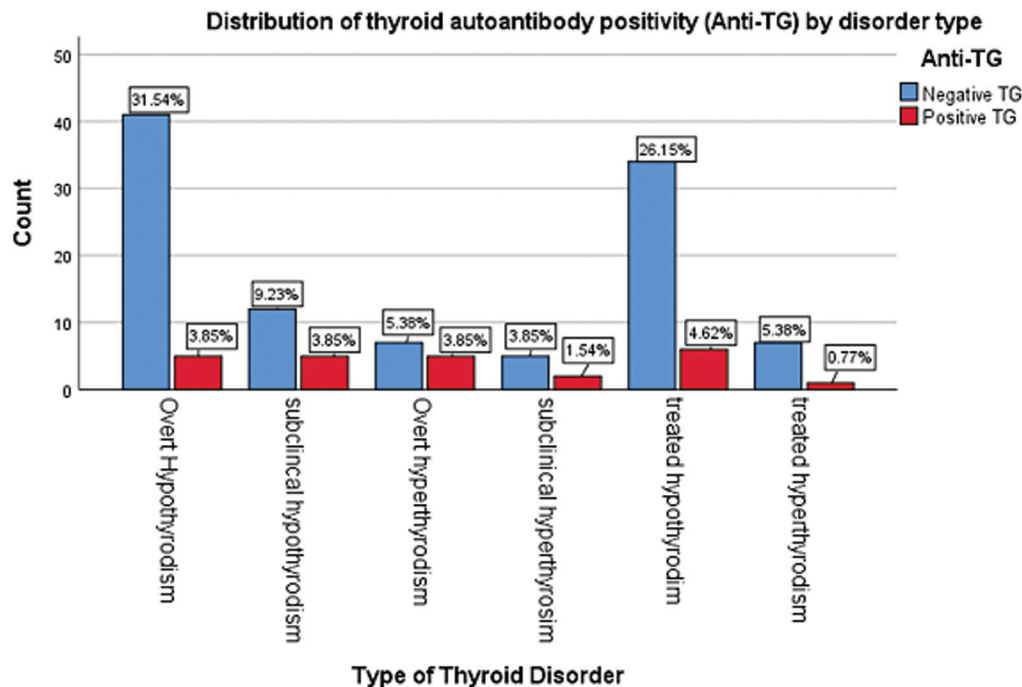


Fig. 2 Distribution of thyroid autoantibody positivity (anti-thyroglobulin [TG]) by disorder type.

Table 4 Logistic regression analysis of factors associated with TPO-Ab and TG-Ab positivity

Variables	TPO Ab		TG Ab	
	OR (CI 95%)	p-Value	OR (CI 95%)	p-Value
Gender	0.63 (0.23–1.74)	0.367	7.76 (0.98–61.57)	0.02
Age	6.41 (0.80–51.14)	0.082	1.02 (0.91–1.15)	0.691
BMI	1.18 (1.02–1.38)	0.03	1.09 (0.95–1.27)	0.194

Abbreviations: Ab, antibody; BMI, body mass index; CI, confidence interval; OR, odds ratio; TG, thyroglobulin; TPO, thyroid peroxidase.

study was conducted to assess the frequency and patterns of thyroid dysfunction and autoimmunity among adults presenting for routine investigations in private medical laboratories in Bani Waleed City. The findings of this study revealed that the frequency of overt hypothyroidism and overt hyperthyroidism was 35.4 and 9.2%, respectively. The percentage of subclinical hypothyroidism and subclinical hyperthyroidism was 13.1 and 5.4%, respectively. Additionally, our study documented that 49.2% of patients with thyroid dysfunction had thyroid antibodies, with 43.1% testing positive for TPO Ab, 22.3% for TG Ab, and 12.3% positive for both antibodies.

Many previous studies have assessed the prevalence of thyroid dysfunction in different populations worldwide. According to a meta-analysis of seven population-based and cohort studies conducted in Western European countries, the overall prevalence of thyroid dysfunction in the general European population was estimated to be 6.7% (95% CI: 6.5–6.9), which included hypothyroidism at 4.9% and hyperthyroidism at 1.7%.²⁶ Globally, the prevalence of hypothyroidism is approximately 0.2 to 5.3%, while subclinical hypothyroidism is around 4 to 15%.²⁷

Previous studies have also investigated the prevalence of thyroid dysfunctions in various Arab and African countries. In Egypt, researchers found that the prevalence of thyroid dysfunctions in the Egyptian population was 29.3%, with the most common types being subclinical and overt hypothyroidism, at 44.4 and 20.6%, respectively, which agrees with the findings of the present study.²⁸ A systematic review by Awad et al aimed at determining the epidemiology of thyroid disorders in the Arab world reported rates ranging from 6.18 to 47.34%.²⁹ The variations in these proportions may be attributed to differences in sample sizes across the studies, as well as factors such as iodine deficiency, dietary habits, and racial or genetic influences. It is noteworthy that the most common causes of thyroid dysfunction are iodine deficiency in iodine-deficient populations and thyroid autoimmunity in iodine-replete populations.³⁰

This study also aimed to assess the frequency of AITDs in adult patients with thyroid disease in Bani Waleed City. High frequency of thyroid antibodies (49.2%) was observed in the current study, which is consistent with the findings of a previous study conducted on Libyan diabetic children, where the rate was 24.3% in the study population.¹⁹ In the present study, the frequency of positive TPO Ab and TG Ab was 43.1 and 22.3%, respectively. These rates are higher compared with other populations. For instance, in the United States, the prevalence of TPO Ab was 11.3%, and for TG Abs, it was 10.4%.

This discrepancy could be due to differences in population characteristics and laboratory methods used.³¹

Regarding the prevalence of autoimmune thyroid disorders in African countries, a review of research conducted by Ogbera and Kuku found that the prevalence rate of AITDs in African countries ranged from 1.2 to 9.9%, with GD and HT being the most common. Moreover, many studies on thyroid antibody profiles in African countries revealed that TPO Ab and TG Ab are the most commonly detected in AITDs. For instance, a study in Nigeria showed that 76.8% of patients with GD had TPO Ab and 11.6% had TG Ab. Additionally, 78.6% of hypothyroidism patients had TPO Ab, while 42% had TG Ab.¹⁸

The sex distribution for thyroid dysfunction in this study clearly demonstrated a female predominance, accounting for 83.1% of cases. The majority of patients were within the 30 to 39 age group, predominantly affected by hypothyroidism and subclinical hypothyroidism. Furthermore, females had a higher prevalence of detected thyroid autoantibodies, at 51.9%. Previous studies have also demonstrated a higher prevalence of thyroid dysfunction in females compared with males.^{32,33}

BMI was significantly associated with thyroid disorders ($p = 0.004$), suggesting that obesity is a risk factor for thyroid disorders in the study population. Higher levels of TSH and the $ft3/ft4$ ratio are also risk factors for being overweight or obese. A cohort study involving 16,975 euthyroid individuals found that thyroid hormones, particularly $ft3$, and the $ft3/ft4$ ratio were positively correlated with BMI. Higher levels of TSH and the $ft3/ft4$ ratio were associated with increased risks of being overweight or obese.³⁴ Another study within the Chinese population found that thyroid dysfunction, especially hypothyroidism, was associated with an increased risk of metabolic syndrome. This relationship was particularly pronounced in women, especially postmenopausal women. The study noted significant associations between high TSH levels and various components of metabolic syndrome, such as obesity and dyslipidemia.³⁵

In the current study, the results showed wide CIs in some variables, which indicate limited precision and statistical uncertainty, even though some predictors in the logistic regression seemed to show significant associations. For instance, the correlation between sex and TG Ab positivity (OR = 7.76, 95% CI: 0.98–61.57) and between age and TPO Ab positivity (OR = 6.41, 95% CI: 0.80–51.14) reveals significant variability, which is likely due to the small sample size. Therefore, larger studies are needed to confirm the observed

trends more accurately, so these findings should be regarded as exploratory.

The main strengths of our study are noteworthy. To begin with, this is the first study to investigate the frequency of thyroid antibodies and shed light on autoimmune thyroid disorders in an adult clinical cohort. However, this study has certain limitations. First, the key limitation of this study is its small sample size, which limits the precision of our estimates, as evidenced by the wide CIs, and prevents meaningful subgroup analysis. It was confined to a single city, limiting the generalizability of the findings. Furthermore, the diagnosis of GD was based on clinical presentation, thyroid function tests, and anti-TPO/anti-TG positivity without measurement of TSH receptor antibodies (TRAb), which is the most specific serological marker for this condition. It is important to note that the diagnosis of GD in our study was based on clinical and biochemical hyperthyroidism with positive anti-TPO/TG Abs, as TRAbs were not measured. TRAb is the most specific serological marker for GD, so our reported frequency should be interpreted as “presumed” GD. Additionally, the study employed a cross-sectional design with a limited sample size. To accurately determine the epidemiology of thyroid disorders and AITDs within the Libyan community, larger population-based studies are necessary. Second, the study observed a higher number of female participants compared with male participants, although this disparity was not statistically significant. Third, our sample was drawn from patients presenting for routine investigations in a private clinic setting and is therefore not representative of the general population. These individuals may have different health concerns or socioeconomic statuses compared with the population at large. Thus, our results are not generalizable and should be interpreted as describing patterns within this specific clinical context only.

Conclusion

This study reveals a high frequency of autoimmune thyroid disorders, with 49.2% of the studied population affected. Notably, the frequency of thyroid antibodies was 43.1% for TPO Ab, 22.3% for TG Ab, and 12.3% for both antibodies. Additionally, hypothyroidism in its various forms was the most frequent thyroid dysfunction observed. Screening strategies to assess the presence of autoimmune thyroid disorders are crucial for better management of thyroid diseases, as the presence of thyroid autoantibodies, particularly TPO Ab, is regarded as a prognostic indicator for the prospective onset of thyroid dysfunction. Future studies with a larger sample size are needed to confirm our findings.

Conflict of Interest

None declared.

Acknowledgments

The authors are grateful to all participants in this study. We also extend our thanks to the medical laboratories in Bani Waleed City, including Alyaqeen Laboratory, Al-

Nogba Laboratory, Ibn-Sina Laboratory, and Oqba Laboratory, for their assistance with sample collection and investigation.

References

- Yen PM. Physiological and molecular basis of thyroid hormone action. *Physiol Rev* 2001;81(03):1097–1142
- Biondi B, Cooper DS. The clinical significance of subclinical thyroid dysfunction. *Endocr Rev* 2008;29(01):76–131
- Meisinger C, Ittermann T, Wallaschofski H, et al. Geographic variations in the frequency of thyroid disorders and thyroid peroxidase antibodies in persons without former thyroid disease within Germany. *Eur J Endocrinol* 2012;167(03):363–371
- Ittermann T, Khattak RM, Nauck M, Cordova CMM, Völzke H. Shift of the TSH reference range with improved iodine supply in Northeast Germany. *Eur J Endocrinol* 2015;172(03):261–267
- Lee HJ, Li CW, Hammerstad SS, Stefan M, Tomer Y. Immunogenetics of autoimmune thyroid diseases: a comprehensive review. *J Autoimmun* 2015;64:82–90
- Carvalho GA, Perez CL, Ward LS, Sterian Ward L. The clinical use of thyroid function tests. *Arq Bras Endocrinol Metabol* 2013;57(03):193–204
- Tsegaye B, Ergete W. Histopathologic pattern of thyroid disease. *East Afr Med J* 2003;80(10):525–528
- Larsson SC, Allara E, Mason AM, Michaëlsson K, Burgess S. Thyroid function and dysfunction in relation to 16 cardiovascular diseases. *Circ Genom Precis Med* 2019;12(03):e002468
- Vanderpump MPJ. The epidemiology of thyroid disease. *Br Med Bull* 2011;99(01):39–51
- Tomer Y. Mechanisms of autoimmune thyroid diseases: from genetics to epigenetics. *Annu Rev Pathol* 2014;9:147–156
- Antonelli A, Ferrari SM, Corrado A, Di Domenicantonio A, Fallahi P. Autoimmune thyroid disorders. *Autoimmun Rev* 2015;14(02):174–180
- Maniakas A, Davies L, Zafereo ME. Thyroid disease around the world. *Otolaryngol Clin North Am* 2018;51(03):631–642
- Pyzik A, Grywalska E, Matyjaszek-Matuszek B, Roliński J. Immune disorders in Hashimoto's thyroiditis: what do we know so far? *J Immunol Res* 2015;2015:979167
- McGrogan A, Seaman HE, Wright JW, de Vries CS. The incidence of autoimmune thyroid disease: a systematic review of the literature. *Clin Endocrinol (Oxf)* 2008;69(05):687–696
- McLeod DSA, Cooper DS. The incidence and prevalence of thyroid autoimmunity. *Endocrine* 2012;42(02):252–265
- Vanderpump MPJ, Tunbridge WM, French JM, et al. The incidence of thyroid disorders in the community: a twenty-year follow-up of the Wickham Survey. *Clin Endocrinol (Oxf)* 1995;43(01):55–68
- Smith TJ, Hegedüs L. Graves' disease. *N Engl J Med* 2016;375(16):1552–1565
- Ogbera AO, Kuku SF. Epidemiology of thyroid diseases in Africa. *Indian J Endocrinol Metab* 2011;15(6, Suppl 2):S82–S88
- Ghawil M, Tonutti E, Abusrewil S, et al. Autoimmune thyroid disease in Libyan children and young adults with type 1 diabetes mellitus. *Eur J Pediatr* 2011;170(08):983–987
- Tomer Y, Huber A. The etiology of autoimmune thyroid disease: a story of genes and environment. *J Autoimmun* 2009;32(3–4):231–239
- Tomer Y, Ban Y, Concepcion E, et al. Common and unique susceptibility loci in Graves and Hashimoto diseases: results of whole-genome screening in a data set of 102 multiplex families. *Am J Hum Genet* 2003;73(04):736–747
- Dunkelmann S, Wolf R, Koch A, Kittner C, Groth P, Schuemichen C. Incidence of radiation-induced Graves' disease in patients treated with radioiodine for thyroid autonomy before and after

- introduction of a high-sensitivity TSH receptor antibody assay. *Eur J Nucl Med Mol Imaging* 2004;31(10):1428–1434
- 23 Laurberg P, Jørgensen T, Perrild H, et al. The Danish investigation on iodine intake and thyroid disease, DanThyr: status and perspectives. *Eur J Endocrinol* 2006;155(02):219–228
- 24 Carlé A, Bülow Pedersen I, Knudsen N, et al. Smoking cessation is followed by a sharp but transient rise in the incidence of overt autoimmune hypothyroidism - a population-based, case-control study. *Clin Endocrinol (Oxf)* 2012;77(05):764–772
- 25 Mizokami T, Wu Li A, El-Kaissi S, Wall JR. Stress and thyroid autoimmunity. *Thyroid* 2004;14(12):1047–1055
- 26 Garmendia Madariaga A, Santos Palacios S, Guillén-Grima F, Galofré JC. The incidence and prevalence of thyroid dysfunction in Europe: a meta-analysis. *J Clin Endocrinol Metab* 2014;99(03):923–931
- 27 Chaker L, Cappola AR, Mooijaart SP, Peeters RP. Clinical aspects of thyroid function during ageing. *Lancet Diabetes Endocrinol* 2018;6(09):733–742
- 28 Rashad NM, Samir GM. Prevalence, risks, and comorbidity of thyroid dysfunction: a cross-sectional epidemiological study. *Egypt J Intern Med* 2019;31:635–641
- 29 Awad SAS, Ashraf EM, Khaled AS, et al. The epidemiology of thyroid diseases in the Arab world: a systematic review. *J Public Health Epidemiol* 2016;8(02):17–26
- 30 Taylor PN, Albrecht D, Scholz A, et al. Global epidemiology of hyperthyroidism and hypothyroidism. *Nat Rev Endocrinol* 2018;14(05):301–316
- 31 Hollowell JG, Staehling NW, Flanders WD, et al. Serum TSH, T4, and thyroid antibodies in the United States population (1988 to 1994): National Health and Nutrition Examination Survey (NHANES III). *J Clin Endocrinol Metab* 2002;87(02):489–499
- 32 Vadiveloo T, Donnan PT, Murphy MJ, Leese GP. Age- and gender-specific TSH reference intervals in people with no obvious thyroid disease in Tayside, Scotland: the Thyroid Epidemiology, Audit, and Research Study (TEARS). *J Clin Endocrinol Metab* 2013;98(03):1147–1153
- 33 Jiang L, Du J, Wu W, Fang J, Wang J, Ding J. Sex differences in subclinical hypothyroidism and associations with metabolic risk factors: a health examination-based study in mainland China. *BMC Endocr Disord* 2020;20(01):100
- 34 Xu R, Huang F, Zhang S, Lv Y, Liu Q. Thyroid function, body mass index, and metabolic risk markers in euthyroid adults: a cohort study. *BMC Endocr Disord* 2019;19(01):58
- 35 He J, Lai Y, Yang J, et al. The relationship between thyroid function and metabolic syndrome and its components: a cross-sectional study in a Chinese population. *Front Endocrinol (Lausanne)* 2021;12(March):661160