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ORIGINAL ARTICLE

Prevalence of Ultrasound-Detected Thyroid Abnormalities in an Apparently Healthy Volunteer Cohort from Alexandria

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ABSTRACT

Background: We aimed to evaluate the prevalence of US-detected thyroid abnormalities among a volunteer group from Alexandria with no prior history of thyroid diseases.

Methods: A cross-sectional cohort included 1000 volunteer participants from the Alexandria population. Based on ultrasound (US) findings, cases were categorized as normal, diffuse non-nodular thyroid disease (NNTD), or nodular thyroid disease (NTD). Thyroid-stimulating hormone (TSH), total triiodothyronine, and tetraiodothyronine were measured in patients with US-abnormal thyroid findings. Thyroid peroxidase antibodies (TPOAbs) were measured in cases with US features suggestive of thyroiditis and thyromegaly. Fine-needle aspiration cytology in NTD followed the ATA-2015 guidelines.

Results: Among our studied cohort, 54.3% were females, with a mean age of 24.2 ± 4.6 years. US thyroid abnormalities were detected in 197/1000 (19.7%); NTD in 68/1000 (6.8%); 129 cases had DNND; 91 cases had thyroiditis (9.1%); and 38 had homogeneous thyromegaly (3.8%). US-detected thyromegaly was found in 103 (10.3%) of 1000 cases. Differentiated thyroid cancer was identified in 5.8% of cases with NTD. TSH was higher in patients with US-detected thyroiditis than in those with NTD and homogenous thyromegaly (P =0.002). Eighty-one % of cases with thyroiditis, and 30% with homogeneous thyromegaly, tested positive for TPOAbs.

Conclusions: In this volunteer group, ultrasound detected thyroid abnormalities in nearly one-fifth of asymptomatic adults, with thyroiditis and nodular disease being the most common findings. These results provide prevalence data for an iodine-sufficient population but should not be viewed as support for routine ultrasound screening, which current guidelines, including the USPSTF, do not recommend.

Keywords: Thyroid; Ultrasound; Thyroid nodules; Goiter; Thyroiditis

INTRODUCTION

Thyroid disorders, both functional and morphological, affect a significant portion of the population. [1,2] Genetic predisposition, racial and ethnic backgrounds, and environmental triggers are the main causes of the wide range of thyroid disorders. [1]

The geographical distribution and iodine availability significantly impact the prevalence of thyroid disorders in various populations. A high rate of goiter is seen in areas with iodine deficiency, reaching up to 80%. [3,4] Conversely, people living in iodine-sufficient regions show a high prevalence of autoimmune thyroid diseases, with or without thyroid dysfunction. [4]

Thyroid nodules are a common clinical issue. [5] It has been observed that nodular thyroid disease is more common in females, older adults, individuals with a history of past irradiation exposure, and in regions with iodine deficiency. [5,6] High-resolution ultrasonography detects thyroid nodules in 19% to 67% of cases. On the other hand, 4-7% of thyroid nodules seen on ultrasound are clinically palpable. [7,8] The vast majority of thyroid nodules are believed to be benign and asymptomatic. [8,9] However, the primary focus in managing thyroid nodules is to rule out cancer, then assess the thyroid's functional status, which may be affected by autonomous transformation of the nodules leading to hyperthyroidism, either subclinical or overt, followed by evaluating compressive symptoms. [9]

Ultrasound (US) is a highly valuable, cost-effective, non-invasive, and accessible tool for diagnosing and managing thyroid disorders, offering a detailed assessment of thyroid volume, echogenicity, and vascularity. [10] Furthermore, extensive epidemiologic studies show that high-resolution ultrasound (HRUS) is the primary method used for evaluating thyroid nodules, providing an estimate of the risk of malignancy and guidance for subsequent fine-needle aspiration cytology. [9, 11, 12]. Despite the limitations of ultrasound, which are primarily due to operator dependence, recent advances in training can help minimize this issue. The different benefits and continued progress highlight the growing need for ultrasonography in the field of thyroidology.

Alexandria is the second-largest city and one of 27 governorates in Egypt, located on the Mediterranean Sea with sufficient iodine levels. Additionally, in 1996, Egypt launched the national salt iodization program. [13] There is ongoing debate about the benefits of screening for thyroid disorders in healthy people living in iodine-sufficient areas. Although goiter and thyroid nodules are often asymptomatic, thyroid dysfunction, autoimmune thyroid diseases, and thyroid cancer can be linked to both conditions. [14]

This study aims to evaluate the prevalence of US-detected thyroid abnormalities among a volunteer group from Alexandria with no prior history of thyroid disease.

METHODS

Research design and settings: A cross-sectional study was conducted at Alexandria Main University Hospital, a tertiary care center.

Study population: The study comprised 1000 healthy volunteers (54.3% female and 45.7% male) with a mean age of 24.2 ± 4.6 years, drawn from the general population. A random sample was recruited from medical students, residents, officers, nurses, workers, and relatives of inpatients in the medical wards. Goiter is not regarded as endemic in the area where this research was undertaken.

Cases who are included are presumably healthy volunteers with no prior history of any thyroid disorder, aged between 18 and 60 years, were included in the study

Cases with a history of any thyroid disorder, thyroidectomy, radioactive iodine ablation, or a history of medications known to impact thyroid function were ruled out of the study were excluded also females were precluded from work during conception or nursing periods.

Data on sociodemographic, family history of autoimmune thyroid disease manifested as hypo or hyperthyroidism, and /or goiter or thyroid cancer were gathered were collected. A detailed clinical examination, including anthropometric measurements and a physical examination of the thyroid gland, was performed.

Venous blood was collected from participants with US-abnormal findings. Serum TSH was measured using a Centaur XP (Siemens, USA) and reported in mIU/L (reference range: 0.306–4.527 mIU/L). Total T3 (TT3) and total T4 (TT4) were measured and reported in ng/dL and µg/dL, respectively (TT3 reference: 60–200 ng/dL; TT4 reference: 4.4–11.2 µg/dL).

Although free hormone testing (FT3/FT4) with equilibrium dialysis is the preferred method, it is not routinely available, and immunoassays are not fully standardized across laboratories;

therefore, validated total hormone assays were used for consistency. TPOAb levels were measured by ELISA (reference: ≤ 34 IU/mL) when ultrasound suggested thyroiditis or thyromegaly.

Evaluation of the thyroid gland by High resolution Ultrasound (HRUS) was carried out by a single expert sonographer using a commercially available real-time instrument (Kontron Imagic Agile) using a 7.5M Hz linear transducer in transverse & longitudinal planes, with a full comment on the 1- Volume of the thyroid gland using the prolate ellipsoid method (volume = length × breadth × depth × π/6) (Thyroid enlargement was defined as thyroid volume ≥18 ml in females, and ≥ 21 ml in males) [r], 2- Echogenicity of the thyroid matrix as compared to surrounding strap muscles 3- Echotexture of the thyroid gland. 4- Vascularity of the thyroid matrix by colour Doppler (classified into cases with no increase in gland vascularity & cases with mild, moderate, or marked increased vascularity), and 5- The presence of nodules, with detailed comment on size, shape, echogenicity, border, margin, halo sign, vascularity, calcification, and presence of cervical lymph nodes. The detected nodules were classified according to their sonographic patterns and risk of malignancy, based on the American Thyroid Association guidelines (ATA 2015). [9]

Ultrasound-guided fine needle aspiration cytology (only in selected cases with thyroid nodules according to the indications of the ATA 2015). Aspirates from FNA were further assessed by a single expert cytopathologist and categorized according to the 2009 Bethesda pathological classification of thyroid nodules. [15]

N.B. Based on ultrasound findings, cases were categorized as normal, diffuse non-nodular thyroid disease (NNTD), or nodular thyroid disease (NTD).

The Ethics Committee approved the study in accordance with the International Ethical Guidelines for Epidemiological Studies. (IRB NO: 00012098, serial NO 0102550) issued on April 3, 2013.

Written consent was obtained from all enrolled individuals after explaining the nature and purpose of the study.

Statistical Methods

Data were analyzed using SPSS v26 (IBM, Armonk, NY). Continuous variables are presented as mean ± SD (or median [IQR] if non-normal), categorical variables as counts and percentages. Normality was assessed with the Shapiro–Wilk test and Q–Q plots. For group comparisons, parametric tests were used when assumptions were met; otherwise, the Mann–Whitney U and Kruskal–Wallis tests were applied (thyroid function comparisons used these non-parametric tests). Correlations used Pearson's r for normal data and Spearman's ρ for non-normally distributed data. A two-tailed $p < 0.05$ was considered statistically significant.

Sample size/precision: A retrospective precision calculation used n=z^2p(1−p)/d^2 with z=1.96. With n=1,000, the 95% CI half-widths are approximately ±2.5% for an overall prevalence near 20%, ±2.0% for prevalences near 7–9% (NTD, thyroiditis), and ±1.2% for prevalences near 4% (homogeneous thyromegaly). Given the rarity of cancer (~0.4%), malignancy estimates are reported descriptively.

RESULTS

The study included 1000 participants: 455 (45.7%) males and 543 (54.3%) females. The sample age ranged from 20 to 55 years, with an average of 24.2 ± 4.6 years. Most of the enrolled cases were under 25 years old (796/1000, 79.6%). The overall cohort's mean BMI was 23.0 ± 3.27 kg/m², with 62.4% (624/1000) being of normal weight, 9% (90/1000) falling into class I obesity, 2.4% (24/1000) suffering from class II obesity, and only 8 cases classified as class III obesity.

46% of patients with ultrasound features consistent with thyroiditis had a positive family history of hypothyroidism. In comparison, 15% had a positive family history of thyroid nodules, and only 8% had a positive family history of hyperthyroidism. While 25% of patients with thyroid nodules had a positive family history of hypothyroidism, 29% had a positive family history of thyroid nodules, and 6% had a positive family history of hyperthyroidism. Around 40% of patients with thyromegaly with normal thyroid echotexture by US had a positive family history of hypothyroidism, while 18% had a positive family history of nodular thyroid disease, and 8% had a positive family history of hyperthyroidism.

The mean volumes by HRUS of the right lobe in males and females were 6.41 ± 3.24 and 5.8 ± 2.55 mL, respectively. The mean volumes of the left lobe in males and females of all studied cases (998) were 5.38 ± 3.31 and 4.87 ± 2.74 mL, respectively. The mean total glandular volumes in males and females were 11.78 ± 6.21 and 10.72 ± 4.99 mL, respectively. The mean difference of right, left, and total thyroid glandular volume was higher in males as compared to females (p values of 0.012, 0.047, and 0.019, respectively).

Mean total thyroid volume showed a statistically significant positive correlation with weight, height, BMI, and BSA (P=0.002, 0.008, 0.01, and 0.006, respectively).

Positive findings based on HRUS:

Based on HRUS, 197 out of 1000 (19.7%) of the total enrolled individuals, 109 out of 543 (20.1%) of the enrolled females, and 88 out of 457 (19.3%) of our total male population had abnormal ultrasound findings of the thyroid gland. (Figures 1-4)

6.8% of the sample (68 out of 197) had nodular thyroid disease, with or without goiter, which accounted for 34.5% of the positive findings; 25 of 68 were solitary thyroid nodules, and 43 of 68 cases showed multinodular goiter (a total of 175 nodules were found by ultrasound).

Ninety-one cases, representing 9.1% of the sample and 46% of the total positive cases, showed ultrasound features consistent with thyroiditis.

Thirty-eight out of 197 cases (3.8% of the sample, 19% of cases) showed evidence of thyromegaly with a normal echotexture of the thyroid gland. (Figure 4).

Out of 1000 cases, 103 (10.3%) showed evidence of thyromegaly on ultrasound. This included 23 cases with thyroid nodules, 8 of which had solitary nodules and 15 had multinodular goiter. There were 42 cases with features consistent with thyroiditis, and 38 cases with normal thyroid echogenicity and echotexture.

Ultrasound detected thyroid nodules:

The total number of cases with thyroid nodules identified by ultrasound was 68 out of 197 (34.5%) overall. Of these, 36 out of 543 were females (6.6%) and 32 out of 457 were males (7.0%); among the 68 NTD cases, 52.9% were female. There was no statistically significant difference between genders ($p = 0.63$). Most cases, 49 out of 68 (72.1%), involved patients aged 25 years or younger, while 19 out of 68 (27.9%) were older than 25 years. A statistically significant difference was observed in the occurrence of thyroid nodules based on age, with higher rates in those aged 25 or younger compared to those over 25 ($p < 0.001$).

It was found that we detected 175 nodules in 68 cases; forty-one per cent (41%) of detected thyroid nodules by US were ≤ 1 cm, thirty-five per cent (35%) were between 1 and 2 cm, and twenty-four per cent (24%) were ≥ 2 cm.

The mean values of total T3, T4, and TSH in patients with thyroid nodules were 112 ± 34 ng/dL, 7.46 ± 1.51 μg/dL, and 4.7 ± 3.10 mIU/L, respectively.

Fifty-five out of 68 cases (81%) with thyroid nodules detected by ultrasound were euthyroid. Thirteen of these 68 cases (19%) had subclinical hypothyroidism. Ten of the 13 cases tested positive for TPO-Abs.

Fine needle aspiration cytology & postoperative histopathology results:

A total of 175 nodules were detected by ultrasound. Twenty-eight cases were candidates for FNA cytology. Cytological examination of the obtained aspirates, based on Bethesda classification, showed 2 out of 28 cases (7.1%) as non-diagnostic (Bethesda I), 16 out of 28 (57.2%) as benign (Bethesda II), and 10 out of 28 cases (35.7%) as indeterminate cytology; 2 of them with atypia of unknown significance (Bethesda III), 6 with follicular neoplasm or suspicious for follicular neoplasm (Bethesda

IV), and 2 cases as suspicious for malignancy (Bethesda V) (Table 1).

Six cases with indeterminate cytology (Bethesda IV) and two cases with suspicion of malignancy (Bethesda V) underwent surgery. Postoperative gross pathology showed that three cases had a benign adenoma, one case had a hyperplastic nodule, three cases had papillary thyroid cancer, and one case had the follicular variant of papillary thyroid cancer.

The estimated incidence of cancer was 0.4% of the total cases studied and 5.8% among cases with thyroid nodules.

Ultrasound-based thyroiditis:

The total number of cases with suggestive features of thyroiditis by ultrasound was 91, with 67.13% being females; female cases were 61 out of 543 (11% of females), while male cases were 30 out of 457 (6.5% of males). There was a statistically significant difference in the incidence of thyroiditis between females and males, with it being higher in females than in males ($p < 0.001$).

Their mean age was ≤ 25 years in sixty-five of 91 cases (72.4%). However, the age-specific incidence was higher among those > 25 years (26/204; 12.7%) than among those ≤ 25 years (65/794; 8%). The difference in thyroiditis incidence by age was statistically significant ($p < 0.001$).

Thyroid function tests in cases with features of thyroiditis detected by ultrasonography:

The average serum levels of total T3, T4, and TSH in patients with thyroiditis were 109 ± 30 ng/dL, 6.65 ± 2.06 μg/dL, and 6.66 ± 6.14 mIU/L, respectively.

Thirty-nine of 91 cases (42.9%) with US features of thyroiditis were euthyroid, while 52 (57.1%) were hypothyroid, including thirty-nine cases with subclinical hypothyroidism and thirteen cases with overt hypothyroidism.

Seventy-four out of 91 cases (81%) tested positive for anti-TPO antibodies.

Ultrasound detected cases with thyromegaly, as well as cases with normal thyroid echogenicity and homogeneous echotexture:

The total number of cases with thyromegaly displaying homogenous echogenicity was 38, with a statistically significant difference in the incidence of homogeneous thyromegaly based on gender, being higher in males (26, 68.4%) compared to females (12, 31.6%). ($p < 0.02$).

Twenty-seven out of 38 cases (71.1%) were 25 years or younger, while 11 cases (28.9%) were older than 25 years. There was a statistically significant difference in the incidence of homogeneous thyromegaly based on age, with higher occurrence in those 25 years or younger compared to those older than 25 years ($p < 0.001$).

The mean serum levels of total T3, T4, and TSH in cases with diffuse homogenous thyromegaly were 116 ± 27 ng/dL, 7.74 ± 1.4 μg/dL, and 3.12 ± 1.15 mIU/L, respectively. (Table 8)

Out of 38 cases of thyromegaly with homogeneous echotexture detected by ultrasound, four had subclinical hypothyroidism, and 30 out of 38 cases tested positive for anti-TPO antibodies.

The average volumes of the right lobe in males and females with thyromegaly were 16.20 ± 3.0 mL and 14.51 ± 3.84 mL, respectively. In contrast, the average volumes of the left lobe in males and females with homogeneous thyroiditis were 15.86 ± 2.61 mL and 14.51 ± 3.84 mL, respectively. The average total volumes in males and females with thyroiditis were 30.91 ± 3.20 mL and 30.37 ± 3.48 mL, respectively.

It has been shown that the mean total volume of cases with homogenous thyromegaly by US had a statistically significant positive correlation with weight, height, BMI, and BSA. (Table 2)

Mean TT3, TT4 & TSH in cases with positive ultrasound thyroid findings:

Table 3 shows mean blood TT3, TT4, and TSH levels in subjects with positive ultrasonography thyroid findings. There was no statistically significant difference in the mean TT3 levels among individuals with thyroiditis, thyroid nodules, and thyromegaly ($p = 0.744$, 0.227, and 0.390, respectively).

The mean TT4 was significantly lower in cases with thyroiditis compared to those with thyroid nodules and thyromegaly ($p = 0.004$ and $p =$

0.003, respectively). However, no statistically significant difference was observed in mean TT4 levels between cases with thyroid nodules and those with thyromegaly (p = 0.47).

The mean TSH level was highest in cases of thyroiditis compared to those with thyroid nodules and thyromegaly (p = 0.002 for each comparison). However, the difference was significant only between cases of thyroid nodules and thyromegaly (p = 0.217).

Table 1: Fine-Needle Aspiration Cytology by Bethesda Classification (n = 28)

Bethesda Class	n (%)
I – non-diagnostic/ non-satisfactory	2 (7.1)
II – Benign	16 (57.1)
III – AUS/FLUS	2 (7.1)
IV – FN/SFN	6 (21.4)
V – Suspicious for Malignancy	2 (7.1)
VI – Malignant	0 (0.0)
Total	28 (100)

AUS/FLUS = Atypia of Undetermined Significance / Follicular Lesion of Undetermined Significance; FN/SFN = Follicular Neoplasm / Suspicious for Follicular Neoplasm; n=number; %: Percentage

Table 2: Correlation Between Anthropometric Measures and Thyroid Gland Volume (TGV) in Cases with Thyromegaly and Normal Echogenicity/Echotexture

Anthropometric Variable	R	p-value
Weight	0.356*	0.028*
Height	0.486*	0.002*
BMI	0.325*	<0.001*
BSA	0.398*	0.013*

* r = Pearson's correlation coefficient
* p < 0.05 considered statistically significant

TGV: Total glandular volume, BMI: Body mass index, BSA: Body surface area, r: =correlation coefficient, P: test of significance

Table 3: Comparison of thyroid function tests in cases with positive ultrasound findings

	US finding			P
	Thyroiditis (n = 91)	Thyroid nodules (n = 68)	Thyromegaly (n=38)	
TT3 (ng/dL)				
Min. – Max.	40 – 170	50 – 200	80– 190	0.487
Mean ± SD	109 ± 30	112 ± 34	116 ± 27	
Sig. bet. grps.	p_1=0.744, p_2=0.227, p_3=0.390			
TT4 (ug/dL)				
Min. – Max.	1.9 – 10.8	2.5 – 10.4	5.3 – 10.5	0.002*
Mean ± SD	6.65 ± 2.06	7.46 ± 1.51	7.74 ± 1.4	
Sig. bet. grps.	p_1=0.004*, p_2=0.003*, p_3=0.470			
TSH (mIU/L)				
Min. – Max.	0.6 – 33.0	1.2 – 22.8	1.20 – 6.10	0.002*
Mean ± SD	6.66 ± 6.14	4.7 ± 3.10	3.12 ± 1.15	
Sig. bet. grps.	p_1=0.002, p_2=0.002*, p_3=0.217			

p_1: p-value for comparing Thyroiditis and Thyroid nodules
p_2: p-value for comparing Thyroiditis and Thyromegaly
p_3: p-value for comparing Thyroid nodules and Thyromegaly
*: Statistically significant at $p \leq 0.05$

US: Ultrasound, TT3: Total triiodothyronine, TT4: Total tetraiodothyronine, TSH: Thyroid-stimulating hormone, Min: Minimum, Max: Maximum, Sig: Significance, Grps: groups, P: test of significance

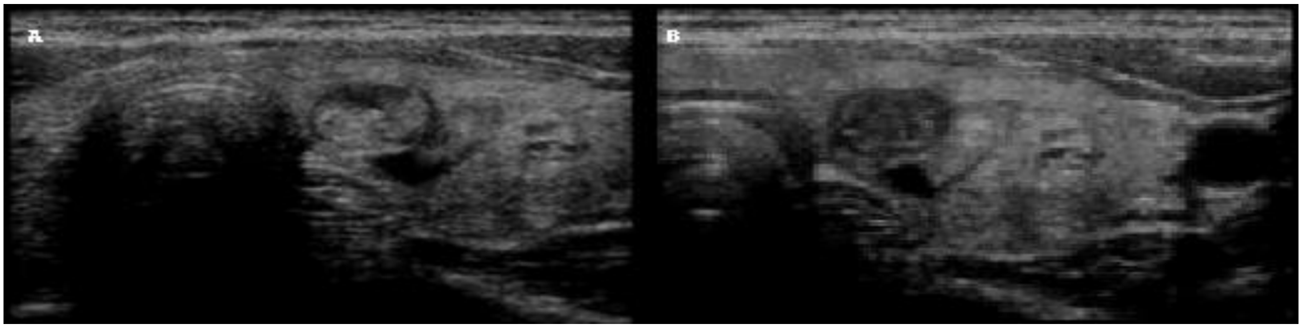

Figure 1: HRUS B-mode, transverse section of the left lobe (A, B). Female patient with diffuse thyroid enlargement harboring multiple nodules. FNAC of the left thyroid nodule was benign (Bethesda II). Gross pathology confirmed benign colloid nodules .

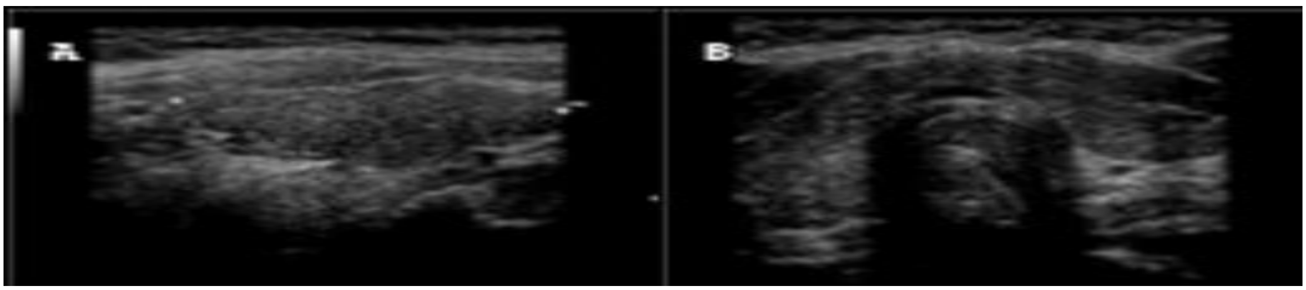

Figure 2: HRUS B-mode, transverse (A) and sagittal (B) sections. Female patient with diffuse hypoechogenicity and marked heterogeneity of the thyroid matrix, consistent with thyroiditis. Laboratory evaluation confirmed Hashimoto's thyroiditis with positive TPO-Abs and subclinical hypothyroidism.

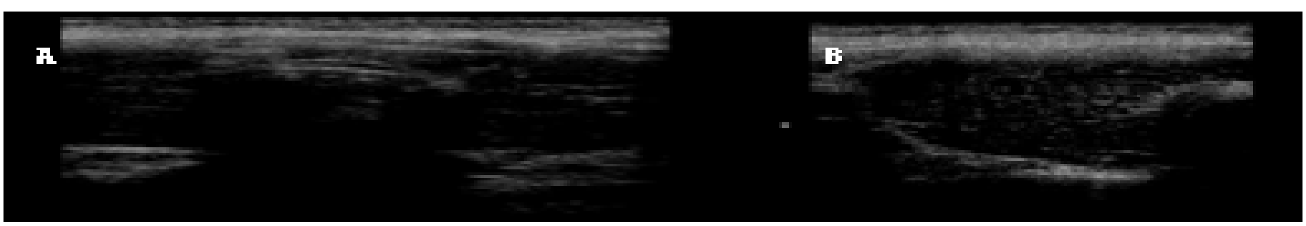

Figure 3: HRUS B-mode, transverse section (A, B). Male patient with diffuse thyroid enlargement, marked hypoechogenicity, and heterogeneous matrix. Diagnosis: Hashimoto's thyroiditis with positive TPO-Abs and overt hypothyroidism.

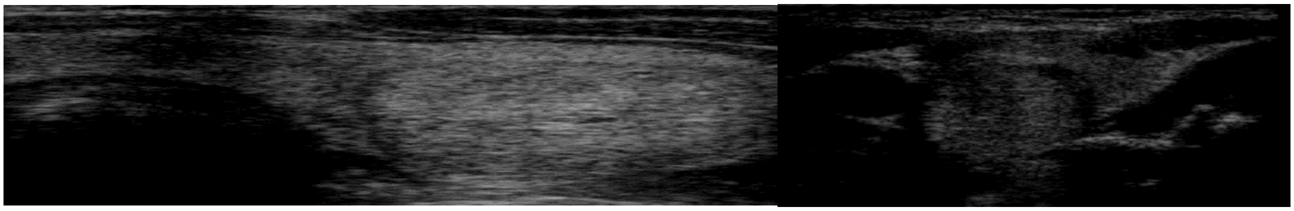

Figure 4: HRUS B-mode, transverse section (A, B). Female patient with multinodular goiter in both thyroid lobes. FNAC of the left thyroid nodule was consistent with follicular neoplasm (Bethesda IV). Gross pathology confirmed follicular variant of papillary thyroid carcinoma (FVPTC).

Figure 5: HRUS B-mode, sagittal section. Female patient with a clinically palpable firm solitary thyroid nodule in the right lobe. Ultrasound showed a highly suspicious lesion. FNAC: Bethesda V (suspicious for malignancy). Gross pathology confirmed papillary thyroid carcinoma.

DISCUSSION

Thyroid disorders are among the most common problems in the general population. Estimates show a high prevalence of goiter and thyroid nodules, especially in areas with iodine deficiency. However, identifying diffuse or nodular thyroid disorders can be difficult because they are often asymptomatic. [1,9]

It is well known that thyroid palpation is the primary method for evaluating diffuse or nodular goiters; however, extensive studies indicate that high-resolution ultrasound is more effective than physical examination for detecting thyroid structural changes. The initial diagnosis based on clinical examination is often revised after ultrasound due to its greater diagnostic accuracy. [16,17]

The prevalence of goiter and nodules varies depending on the studied population. Genetic, ethnic, and environmental factors play a crucial role in determining their occurrence. [1,2]

We aimed to screen for thyromegaly and thyroid nodules among the Alexandria population without any prior history of thyroid disorders.

One hundred and ninety-seven out of 1000 cases (19.7%) showed abnormal thyroid morphology based on ultrasound examination of the thyroid gland. The prevalence of thyroid nodules detected by ultrasound was 6.8% (68/1000 cases); 25 cases had a single thyroid nodule, while 43 cases showed evidence of multiple thyroid nodules. Ninety-one out of 1000 cases (9.1%) had diffused hypoechoic and heterogeneous thyroid matrix, consistent with thyroiditis. Thirty-eight out of 1000 cases (3.8%) had evidence of thyromegaly, normal thyroid echogenicity, and echotexture. It has been observed that the prevalence of thyromegaly in our study is 10.3% (103/1000 cases); specifically, 23 cases involved nodular thyroid disease, 42 cases showed evidence of thyroiditis, and 38 cases had normal thyroid echogenicity and echotexture.

The prevalence of thyroid disorders and thyroid nodules in asymptomatic patients has been the subject of extensive research. However, many of these studies focused on areas with mild, moderate, and severe iodine deficiency. Reiners et al. [18] in a German study reported a prevalence of thyroid disorders in 33% of employees without a previous history of thyroid disorders. In an Italian study, a higher prevalence of thyroid disorders was found to be 50% of the enrolled cases. [19]

In another study, Delitia et al. [20] reported a high prevalence of thyroid structural changes among individuals without a prior diagnosis of thyroid disease in an area of mild to moderate iodine deficiency in Sardinia. Based on US findings, the study reported a prevalence of nodules in 17.4% and goitre in 22% of the subjects recruited.

The high incidence of detected thyroid nodules and goiters in previous studies, compared to our findings, was attributed to the fact that they conducted their study in areas with iodine deficiency.

Our study revealed that the incidence of thyroid nodules detected by HRUS was 6.8%, with females accounting for 3.6% and males for 3.2%. Our study found no statistically significant difference between the prevalence of thyroid nodules in females and males. The low incidence of thyroid nodules detected by ultrasound in our study, compared to the estimates from other epidemiologic studies, is attributed to the young age of most of our enrolled cases, with 80% being ≤ 25 years. In addition, they were almost equally divided by gender, with 54.3% females and 45.7 % males. It is known that the incidence of nodules increases with age and is said to be more common in females.

We identified differentiated thyroid cancer (DTC) in 0.4% of the total enrolled cases and in 5.9% of cases with thyroid nodules. It has been recognised based on the last estimates that the prevalence of thyroid cancer shows a step rise, where advances in technologies for the detection of thyroid cancer have been proposed to be the main culprit in the uncovering of occult thyroid cancer. [21,22]

In general, the frequency of cancers detected by ultrasound screening increased 8.4-fold from 1999 to 2008. Nevertheless, it is worth mentioning that the increase in thyroid cancer is most likely attributed to a rise in the prevalence of papillary thyroid cancer rather than other cancer histological subtypes and is likely due to small tumors. As a result, the ATA's 2015 guidelines advised against screening for thyroid cancer to avoid overdiagnosis and recommended active surveillance instead of intervention for low-risk cancers. [9]

However, other practitioners recommend screening for TC to facilitate early detection of cases, as postulated by Gnarini et al. [19], who reported a prevalence rate of 1% among the overall subjects and 2% among those affected by nodular goiter in a screening program of a normal, healthy population. Additionally, he proposed that the overall detection rate of DTC was much higher compared to screening programmes for breast and colorectal cancers, concluding that ultrasound can assist in the early identification and detection of DTC in asymptomatic patients.

There are several causes of thyromegaly, including hormonal, inflammatory, metabolic, or immune-related factors. Various influences, such as iodine intake, genetic background, and geographic location, affect thyroid volume measurements. [23]

Additionally, it is known that thyroid volume varies in certain physiological states, such as pregnancy. It has been observed that thyroid volume increases during pregnancy and in the early postpartum period, then begins to regress up to 12 months postpartum. [24] Moreover, the size of the thyroid undergoes cyclic changes throughout the menstrual cycle. [25]

Our study observed a significantly larger mean thyroid volume in males compared to females among the total enrolled cases. Moreover, it was found that the mean thyroid volume correlated considerably with weight, height, BSA, and BMI in our studied cases, which is consistent with previous studies' findings. [26-28]

After excluding cases with nodular goitre, ultrasound revealed evidence of thyromegaly in 80/1000 cases. Out of 80 cases, 42 cases had a hypoechoic pattern of the thyroid with mild to marked heterogeneity, consistent with features of thyroiditis. In comparison, 38 cases were evidently enlarged by US, showing normal echogenicity with homogeneous echotexture of the thyroid gland.

Defining a patient as having a normal or enlarged thyroid gland based on ultrasound is a matter of debate. In many studies, a significant correlation has been observed between thyroid gland volume and patients' body surface area, body mass index, weight, height, age, and sex. [26-28]

Another essential determinant of thyroid volume is the geographical distribution and iodine sufficiency, where different mean thyroid volumes have been observed in various areas. In a study held in Turkey, [23] the mean volume of the studied population was 12.98 ± 2.53 mL. At the same time, lower values were observed in a study conducted by Hsiao and Chang in China, where the mean thyroid volume among the Chinese population was measured at 7.7 ± 3.3 mL [27].

This value may be attributed to the relatively short stature of the Chinese population. In a study conducted in Denmark, the mean thyroid volumes were 19.6 mL and 17.5 mL in males and females, respectively. [28] respectively. The relatively higher values observed in the Danish study were attributed to relative iodine deficiency in Denmark and the tall stature of the Danish population. Similarly, Barrere et al. [29] from France reported that thyroid volume was positively correlated with age, height, weight, and BSA in both genders and negatively correlated with age in women. In the same study conducted by Barrere et al., intriguing findings were observed: thyroid volumes were larger in smokers compared to ex-smokers, and smaller volumes were reported in oral contraceptive users. [25]

An ultrasound scan can characterise the echographic structure of the thyroid gland. [30] In autoimmune thyroid diseases, a reduction in thyroid echogenicity by ultrasound is commonly encountered, likely due to both lymphocytic infiltration and disruption of the normal tissue architecture, in contrast to the high echogenicity of the normal thyroid parenchyma caused by the follicle structure. [31] Currently, thyroid hypo-echogenicity is viewed as an early sign of thyroid autoimmunity, which may even precede the clinical suspicion of the thyroid disorder. [32]

Previous studies demonstrated that in patients with thyroid autoimmune diseases, the presence of circulating thyroid antibodies (Abs) as well as the development of hypothyroidism was closely correlated with the degree of thyroid hypo-echogenicity. [33,34]

Our study revealed that 91 cases (9.1%) exhibited a hypoechoic, heterogeneous echo texture of the thyroid gland, ranging from mild to marked heterogeneity, consistent with the features of thyroiditis. Fifty-two out of 91 cases (76%) with US features of thyroiditis were hypothyroid, either subclinical or overt, and seventy-four out of 91 cases (81%) showed seropositivity for anti-TPO. Among the 91 cases with suggestive thyroiditis, 61 were females and 30 were males, indicating a significant female predominance that is consistent with previous studies.

Pedersen et al. [35] conducted a study to assess the validity of diffuse reduction in thyroid echogenicity as a predictor of AITD, finding that nearly 91% of subjects with this reduction had at least one laboratory finding consistent with possible AITD. The study found that the positive and negative predictive values of reduced thyroid echogenicity as an indicator of AITD were 88.3% and 93%, respectively. In Denmark, Vejbjerg and his group randomly selected 4,649 healthy adult subjects to investigate the association between the echogenicity of the thyroid/irregular echo patterns with thyroid function in the general population.

They found that people with lower echogenicity had a higher average TSH level than those with normal echogenicity, and this link was even stronger in those with very low echogenicity. [36] In another study by Rago et al. [32], they found that hypoechogenicity elicited by the US was a better predictor than thyroid antibodies in the detection of thyroid dysfunction. in apparently healthy subjects

To summarise, thyroid abnormalities were detected in 197 (19.7%) of 1000 cases; 68 (6.8%) of 1000 had evidence of NTD—25 with solitary thyroid nodule and 43 with multinodular goiter—139 cases with diffuse thyroid pathology, 91 cases with features consistent with thyroiditis with/without thyroid enlargement (9.1%), and 38 cases with thyromegaly with normal thyroid echogenicity and echotexture (3.8%) were noted. US-based thyromegaly was detected in 103 (10.3%) of 1000 cases.

A positive family history (FH) of AITD was found in 54% of cases with thyroiditis. Cases with NTD had a 29% positive FH of thyroid nodules. Approximately 40% of patients with thyromegaly with normal thyroid echotexture had a positive FH of AITD. Cases with NTD showed slight female predominance (53% females vs 47% males). Three-quarters of the detected thyroid nodules were subcentimeter. Differentiated thyroid cancer was found in 5.8% of cases with NTD. The mean serum TSH level was significantly higher in patients with sonographic features suggestive of thyroiditis than in those with NTD and thyromegaly, characterized by normal thyroid echogenicity ($P = 0.002$).

81% with thyroiditis had positive TPOAbs. Cases with thyromegaly with normal thyroid echotexture were euthyroid with positive TPOAbs in 30% of cases. Cases with thyroiditis and thyromegaly showed a significant positive correlation between the total thyroid volume and body mass index ($P = 0.06$ and $P = 0.05$, respectively).

CONCLUSIONS

Thyroid abnormalities were detected by ultrasound in about one in five asymptomatic adults, with thyroiditis and nodular disease being the most common findings. Our results align with European prevalence studies, which also reported frequent ultrasound-detected thyroid changes in asymptomatic populations. These findings add epidemiological data from an iodine-sufficient Middle Eastern group and highlight the role of ultrasound in characterizing subclinical thyroid morphology. However, consistent with the US Preventive Services Task Force and international guidelines [37], our results should not be taken as support for population-wide ultrasound screening. Instead, they provide descriptive data that may aid in clinical risk assessment and inform future research.

Strengths and limitations:

This study has several strengths. It represents one of the largest cohorts from an iodine-sufficient Middle Eastern population, including 1,000 volunteers systematically evaluated by high-resolution ultrasound. A single experienced operator performed ultrasound examinations to minimize interobserver variability. Additionally, our sample size estimates provided statistically reliable prevalence figures. However, several limitations should also be acknowledged. First, the study primarily involved young adults, which may limit its generalizability to the broader population. Second, total T3 and T4 were measured instead of free T3 and T4.

Although the latter are recommended by guidelines, free hormone assays require equilibrium dialysis or less standardized immunoassays, so total hormone assays were used for consistency within our laboratory. Furthermore, cytology results were reported using the 2009 BSRTC; we did not re-examine cases for NIFTP reclassification, which could slightly influence malignancy risk estimates in indeterminate categories. Finally, because thyroid cancer is rare in this cohort, prevalence estimates should be interpreted with caution.

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