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Prevalence of Thyroid Dysfunction Among Children and Adolescents in Tripoli, Western Libya: A Cross-Sectional Study

Mohamed Alnaied[1*], Mabrouka Abuajila[2], Siraj Al-Din Al-Zarqani[3], Fatima Al-Wafi[4]
[1]Department of Biotechnology, Faculty of Science, Azzaytuna University, Tarhuna, Libya
[2,3,4]Department of Medical Technologies, Higher Institute of Science and Technology, Awlad Ali, Tarhuna, Libya

مدى انتشار اضطرابات الغدة الدرقية بين الأطفال والمراهقين في طرابلس، غرب ليبيا: دراسة مقطعية

محمد النايض[1*]، مبروكة أبوعجيلة[2]، سراج الدين الزرقاني[3]، فاطمة الوافي[4]
[1]قسم التقنية الحيوية، كلية العلوم، جامعة الزيتونة، ترهونة، ليبيا
[2،3،4]قسم التقنيات الطبية، المعهد العالي للعلوم والتقنية، أولاد علي، ترهونة، ليبيا

*Corresponding author: mohamed85alnaied@gmail.com

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Abstract:

Background: Thyroid hormones are essential for normal growth, neurodevelopment, energy metabolism, and maintenance of physiological homeostasis during childhood and adolescence. Thyroid dysfunction may present with nonspecific manifestations, and biochemical abnormalities may remain undetected without laboratory assessment. Pediatric thyroid disorders vary considerably according to age, sex, nutritional status, environmental exposure, genetic background, and population characteristics. Objective: This study aimed to determine the prevalence and distribution of biochemical thyroid hormone abnormalities among children and adolescents aged 6-15 years in Tripoli, Western Libya, and to describe their distribution according to sex and age, together with selected anthropometric characteristics, symptoms, and family history of thyroid disease. Methods: A community-based cross-sectional study was conducted among 101 children and adolescents aged 6-15 years residing in Tripoli, Western Libya. Participants were selected using a random sampling approach. Demographic and clinical information was collected using a structured questionnaire. Approximately 5 mL of venous blood was collected from each participant. Serum was separated by centrifugation and analyzed for thyroid-stimulating hormone (TSH), triiodothyronine (T3), and thyroxine (T4) using an iFlash 1800 automated analyzer at Al-Reem Laboratory. Hormone concentrations were interpreted according to the laboratory reference intervals used in the study. Results: Among the 101 participants, 51 (50.49%) were males and 50 (49.51%) were females. Fifty-eight participants (57.42%) were aged 6-10 years and 43 (42.58%) were aged 11-15 years. The overall mean TSH concentration was 2.12 ± 1.691 µIU/mL, mean T3 was 1.32 ± 0.784 nmol/L, and mean T4 was 85.27 ± 28.542 nmol/L. TSH concentrations were within the reference range in 74 participants (73.3%), above the range in 11 (10.9%), and below the range in 16 (15.8%). T3 concentrations were within the reference range in 68 participants (67.3%), above it in 10 (9.9%), and below it in 23 (22.8%). T4 concentrations were within the reference range in 83 participants (82.2%) and below it in 18 (17.8%); no participant had a T4 concentration above the reference range.

Conclusion: Most participants had TSH, T3, and T4 concentrations within the laboratory reference ranges. Nevertheless, biochemical deviations were observed in a proportion of children and adolescents. These findings provide preliminary evidence of thyroid hormone abnormalities among children in Western Libya and are broadly consistent with the only comparable community-based Libyan pediatric dataset, from Tobruk, although the proportion of abnormal results was higher in the present sample. Larger population-based studies using age- and sex-specific pediatric reference intervals and a more comprehensive thyroid profile are required.

Keywords: Thyroid dysfunction; children; adolescents; TSH; T3; T4; Tripoli; Western Libya; Libya; cross-sectional study.

الملخص:

الخلفية: تُعد هرمونات الغدة الدرقية ضرورية للنمو الطبيعي، والتطور العصبي، واستقلاب الطاقة، والحفاظ على الاتزان الفسيولوجي خلال مرحلتي الطفولة والمراهقة. وقد يظهر اختلال وظائف الغدة الدرقية بأعراض غير نوعية، كما قد تظل الاضطرابات الكيميائية الحيوية غير مكتشفة في غياب التقييم المخبري. وتختلف اضطرابات الغدة الدرقية لدى الأطفال بشكل ملحوظ تبعًا للعمر، والجنس، والحالة التغذوية، والتعرضات البيئية، والخلفية الوراثية، وخصائص السكان. الهدف: هدفت هذه الدراسة إلى تحديد مدى انتشار وتوزيع الاضطرابات الكيميائية الحيوية في هرمونات الغدة الدرقية لدى الأطفال والمراهقين الذين تتراوح أعمارهم بين 6 و15 عامًا في طرابلس، غرب ليبيا، ووصف توزيع هذه الاضطرابات وفقًا للجنس والعمر، إلى جانب بعض الخصائص الأنثروبومترية المختارة، والأعراض، والتاريخ العائلي لأمراض الغدة الدرقية. الطرق: أُجريت دراسة مقطعية مجتمعية شملت 101 طفل ومراهق تتراوح أعمارهم بين 6 و15 عامًا، من المقيمين في طرابلس، غرب ليبيا. وتم اختيار المشاركين باستخدام أسلوب أخذ عينات عشوائي. جُمعت المعلومات الديموغرافية والسريرية باستخدام استبيان مُنظَّم. وسُحبت نحو 5 مل من الدم الوريدي من كل مشارك، ثم فُصل المصل بالطرد المركزي، وأُجريت تحاليل الهرمون المنبه للغدة الدرقية (TSH)، وثلاثي يودوثيرونين (T3)، وثيروكسين (T4)، باستخدام جهاز (iFlash 1800) الآلي في مختبر الريم. وفُسرت تراكيز الهرمونات وفقًا للقيم المرجعية المختبرية المعتمدة في الدراسة. النتائج: من بين المشاركين البالغ عددهم 101، كان 51 (50.49%) من الذكور و50 (49.51%) من الإناث. وكان 58 مشاركًا (57.42%) ضمن الفئة العمرية 6–10 سنوات، بينما كان 43 (42.58%) ضمن الفئة العمرية 11–15 سنة. بلغ المتوسط العام لتركيز (TSH)µIU/mL 1.691 ± 2.12 ، ومتوسط(T3) nmol/L 0.784 ± 1.32، ومتوسط(T4) nmol/L 28.542 ± 85.27 وكانت تراكيز TSH ضمن المدى المرجعي لدى 74 مشاركًا (73.3%)، وأعلى من المدى المرجعي لدى 11 (10.9%)، وأقل منه لدى 16 (15.8%). وكانت تراكيز T3 ضمن المدى المرجعي لدى 68 مشاركًا (67.3%)، وأعلى منه لدى 10 (9.9%)، وأقل منه لدى 23 (22.8%). أما تراكيزT4 ، فكانت ضمن المدى المرجعي لدى 83 مشاركًا (82.2%) وأقل منه لدى 18 (17.8%)، ولم يُسجل أي مشارك لديه تركيز T4أعلى من المدى المرجعي. الخلاصة: كانت تراكيز TSH و T3وT4ضمن القيم المرجعية المختبرية لدى معظم المشاركين. ومع ذلك، لوحظت انحرافات كيميائية حيوية لدى نسبة من الأطفال والمراهقين. وتوفر هذه النتائج دليلًا أوليًا على وجود اضطرابات في هرمونات الغدة الدرقية بين الأطفال في غرب ليبيا، وتتوافق بصورة عامة مع بيانات المجتمع الليبية الوحيدة المماثلة المتاحة لدى الأطفال، وهي الدراسة التي أُجريت في طبرق، رغم أن نسبة النتائج غير الطبيعية كانت أعلى في العينة الحالية. وتُعد هناك حاجة إلى إجراء دراسات أكبر قائمة على السكان، باستخدام قيم مرجعية خاصة بالأطفال ومصنفة حسب العمر والجنس، إلى جانب تقييم أكثر شمولًا لوظائف الغدة الدرقية.

الكلمات المفتاحية: اختلال وظائف الغدة الدرقية؛ الأطفال؛ المراهقون؛ الهرمون المنبه للغدة الدرقية(TSH) ؛ ثلاثي يودوثيرونين (T3)؛ ثيروكسين (T4)؛ طرابلس؛ غرب ليبيا؛ دراسة مقطعية.

Introduction:

The thyroid gland plays a fundamental role in maintaining metabolic homeostasis and supporting normal growth and development. Thyroxine (T4) and triiodothyronine (T3) regulate energy expenditure, protein synthesis, cardiovascular activity, skeletal development, and neurological maturation. Thyroid hormone production is controlled primarily through the hypothalamic-pituitary-thyroid axis, in which thyroid-stimulating hormone (TSH) acts as a major regulator of thyroid hormone synthesis and secretion [1].

During childhood and adolescence, adequate thyroid hormone availability is particularly important because this period is characterized by rapid physical growth, maturation of the nervous system, and substantial changes in body composition. Thyroid disease in children differs from adult thyroid disease with respect to etiology, clinical presentation, age distribution, and consequences for development. Pediatric thyroid disorders may include congenital and acquired hypothyroidism, autoimmune thyroiditis, Graves' disease, thyroid nodules, and other structural or functional abnormalities [1,2].

The clinical presentation of thyroid dysfunction in children is often nonspecific. Hypothyroidism may be associated with fatigue, growth retardation, weight changes, dry skin, hair abnormalities, and cognitive or attention difficulties, whereas hyperthyroidism may manifest as palpitations, sweating, tremor, sleep disturbance, emotional changes, and accelerated growth. However, many of these symptoms can occur in healthy children for reasons unrelated to thyroid disease. Therefore, biochemical evaluation remains an important component of thyroid assessment [1].

The incidence and pattern of pediatric thyroid disease differ among populations. Oyenusi et al., in a 10-year retrospective study from Nigeria, demonstrated that pediatric thyroid disorders represented a heterogeneous group, with congenital hypothyroidism constituting a substantial proportion of cases [3]. Similarly, Yelluri [4] reported variation in the incidence and etiology of thyroid disorders among children and emphasized the importance of iodine status and autoimmune thyroiditis in pediatric thyroid disease.

Community-level data specific to Libya remain particularly scarce. A rare community-based study from Tobruk, eastern Libya, retrospectively reviewed thyroid function testing in 234 children and adolescents and found that the overwhelming majority (97.9%) were euthyroid, with only 2.1% showing any thyroid dysfunction; the authors themselves noted that most existing pediatric thyroid literature is hospital-based and may overestimate true population prevalence, and they called explicitly for further community-based studies from other Libyan regions [5]. The present study, conducted in Tripoli, responds directly to that call.

Thyroid function during adolescence may also vary according to sex and population characteristics. A recent nationally representative study of US adolescents aged 12-18 years reported differences in thyroid dysfunction according to age, sex, and racial/ethnic characteristics, with subclinical hyperthyroidism being the most frequently observed biochemical abnormality [6]. Such findings demonstrate the importance of considering demographic characteristics when interpreting thyroid function in children and adolescents.

Thyroid dysfunction may also occur in association with particular pediatric conditions. Children with Down syndrome have a substantially increased risk of thyroid abnormalities and therefore require appropriate thyroid surveillance [7]. In addition, thyroid function may be influenced by nutritional status and abnormal eating patterns. Calcaterra et al. described alterations in thyroid function among children and adolescents affected by undernutrition and overnutrition, highlighting the interaction between nutritional status and the hypothalamic-pituitary-thyroid axis [8].

Obesity represents another important factor when evaluating thyroid function in children. A recent cross-sectional study in Bangladesh reported higher TSH and FT3 and lower FT4 concentrations among obese children and adolescents compared with normal-weight participants, demonstrating an association between body mass index and thyroid hormone concentrations [9].

Thyroid disorders may also affect health-related quality of life and mental wellbeing. A nationwide study of children and adolescents demonstrated that most children with thyroid dysfunction or thyroid autoimmunity did not show significant impairment of health-related quality of life or mental health, reinforcing the importance of considering the broader psychosocial consequences of thyroid disease and avoiding unnecessary alarm when mild biochemical abnormalities are detected on screening [10].

Structural thyroid disorders and thyroid carcinoma are less common than functional disorders but remain clinically important in pediatric populations. A systematic review by Vaisman et al. emphasized the distinctive characteristics of thyroid carcinoma in children and adolescents and the challenges associated with its diagnosis and management [11]. Similarly, pediatric thyroid disease requiring surgical treatment represents a heterogeneous group in which appropriate diagnosis and treatment selection are important for minimizing complications [12].

The interpretation of thyroid function tests requires particular caution. TSH, T3, and T4 concentrations should be considered together rather than interpreted as isolated measurements. Abnormal combinations may occur because of primary thyroid disease, medications, assay interference, hormone resistance, or pituitary disorders [13,14]. Consequently, an isolated high or low concentration of one thyroid hormone should not automatically be classified as definitive hyperthyroidism or hypothyroidism.

Nutritional iodine status is another important determinant of thyroid function. Studies conducted in Libya have examined awareness of thyroid disorders and iodine-rich diets and have emphasized the importance of dietary iodine in thyroid health [15]. Research among Libyan populations has also examined dietary factors and thyroid disorders, demonstrating the continuing importance of nutritional and environmental factors in the epidemiology of thyroid disease [16].

Several Libyan studies have reported thyroid dysfunction in different populations. A study from Derna investigated thyroid disorders according to age and sex, providing evidence of regional variation in thyroid disease within Libya [17]. Another study conducted in the Al-Wahat region reported the prevalence of thyroid disorders during 2022 [18]. These studies provide important local evidence, but, together with the Tobruk data described above [5], they do not specifically characterize thyroid hormone abnormalities among children and adolescents in Tripoli, Libya's capital and largest urban center.

Other studies have investigated thyroid-related biochemical abnormalities in Libyan adults. El Mabrouk et al. evaluated thyroid dysfunction among Libyan patients with type 2 diabetes mellitus and reported thyroid abnormalities in a substantial proportion of participants [19]. The relationship between thyroid dysfunction and metabolic parameters has also been demonstrated among Libyan patients, including a positive relationship between TSH and total cholesterol among patients with hypothyroidism [20].

Thyroid dysfunction has also been investigated in populations with diabetes mellitus and other chronic conditions internationally. These studies demonstrate that thyroid abnormalities may occur in clinically selected populations, although their findings cannot be directly extrapolated to apparently healthy children in the general population [21,22].

The epidemiology of thyroid dysfunction in the Middle East has been summarized in a systematic review and meta-analysis, which demonstrated considerable variation in prevalence between countries and populations [23]. Such variation supports the need for locally generated epidemiological data rather than reliance exclusively on estimates derived from other populations.

Thyroid function may also be affected by developmental and neurodevelopmental conditions. A recent meta-analysis found significant differences in several thyroid hormones and thyroid autoantibodies among children and adolescents with neurodevelopmental disorders compared with healthy controls, suggesting that thyroid-related biochemical alterations may occur in specific pediatric populations [24].

Although thyroid disorders have been investigated in several Libyan populations, apart from the single Tobruk community sample [5] there remains very limited information concerning thyroid function among apparently healthy children and adolescents in Western Libya. Therefore, the present study was designed to determine the distribution of serum TSH, T3, and T4 concentrations among children and adolescents aged 6-15 years in Tripoli and to describe their distribution according to sex, age, anthropometric characteristics, symptoms, and family history of thyroid disease.

Materials and Methods:

1. Study Design and Setting:

A community-based cross-sectional study was conducted among children and adolescents aged 6-15 years residing in Tripoli, Western Libya, during 2024-2025. Laboratory investigations were performed at Al-Reem Laboratory, Tripoli. The cross-sectional design was selected because it permits assessment of the distribution of biochemical thyroid abnormalities within a defined population during a specified period.

2. Study Population:

The study included 101 children and adolescents aged 6-15 years. Children with a previously diagnosed thyroid disorder were excluded. Participants with chronic diseases that could influence thyroid function, including diabetes mellitus, were excluded. Children receiving medications known to interfere with thyroid function, including corticosteroids and iodine-containing medications, were also excluded. Parental or legal guardian consent was obtained before participation.

3. Sampling Technique:

Participants were selected using a simple random sampling approach from eligible children aged 6-15 years residing in Tripoli. The final study sample consisted of 101 participants.

4. Questionnaire and Clinical Data Collection:

A structured questionnaire was used to obtain demographic and clinical information, including age, sex, medical history, family history of thyroid disorders, and selected symptoms potentially associated with thyroid dysfunction. For younger children, information was obtained from parents or legal guardians.

Symptoms potentially associated with hyperthyroidism included changes in the face and eyes, difficulty sleeping, sweating, tremors, mood changes, and rapid heartbeat. Symptoms potentially associated with hypothyroidism included fatigue and weakness, weight changes, dry skin, hair loss, growth problems, and attention or memory difficulties.

5. Blood Collection and Laboratory Analysis:

Approximately 5 mL of venous blood was collected from each participant by trained medical personnel using sterile disposable equipment. Blood samples were transferred into serum separation tubes and labeled using unique participant identification codes. Samples were centrifuged at approximately 3000 rpm for 10 minutes to separate serum. Separated serum was transferred into appropriately labeled tubes and stored at -20°C when immediate analysis was not possible.

Serum concentrations of the following thyroid-related hormones were measured: thyroid-stimulating hormone (TSH), triiodothyronine (T3), and thyroxine (T4). The laboratory analyses were performed using an iFlash 1800 automated analyzer according to the established procedures of the laboratory.

The reference intervals used in the present study were: TSH 0.4-4.0 μIU/mL; T3 0.8-2.0 nmol/L; T4 57.9-150.6 nmol/L. Participants were classified as having hormone concentrations within, above, or below the laboratory reference interval.

Importantly, these categories describe individual biochemical measurements and should not automatically be interpreted as definitive diagnoses of hyperthyroidism or hypothyroidism. Clinical diagnosis requires interpretation of the complete thyroid profile together with clinical findings. [13,14]

6. Anthropometric Measurements:

Body weight was recorded in kilograms and height in centimeters. Anthropometric information was collected to describe the study population and to provide additional information for interpretation of thyroid-related findings.

7. Data Quality Control:

Each questionnaire and laboratory sample was assigned a unique identification code. Questionnaires were reviewed for completeness before data entry. Laboratory results were checked against the original laboratory records. Participant confidentiality was maintained throughout the study.

8. Statistical Analysis:

Data were analyzed using descriptive statistical methods. Categorical variables were expressed as frequencies and percentages. Continuous variables were expressed as means and standard deviations. Mean TSH, T3, and T4 concentrations were calculated for the total study population and separately for males and females. The proportions of participants with hormone concentrations within, above, and below the laboratory reference intervals were also calculated. Because the available dataset provided descriptive results rather than complete inferential analyses, the present study focuses primarily on descriptive statistics.

9. Ethical Considerations:

Participation was voluntary. Parental or guardian consent was obtained before questionnaire administration and blood collection. Participant confidentiality was maintained by using identification codes rather than personal names.

Results:

1. Demographic Characteristics:

A total of 101 children and adolescents aged 6-15 years were included. Among the participants, 51 (50.49%) were males and 50 (49.51%) were females. Regarding age distribution, 58 participants (57.42%) were aged 6-10 years and 43 (42.58%) were aged 11-15 years (Table 1, Figure 1).

Table (1): Distribution of study participants according to sex and age group.

Variable	Category	n	%
Sex	Male	51	50.49
	Female	50	49.51
	Total	101	100.00
Age group	6-10 years	58	57.42
	11-15 years	43	42.58
	Total	101	100.00

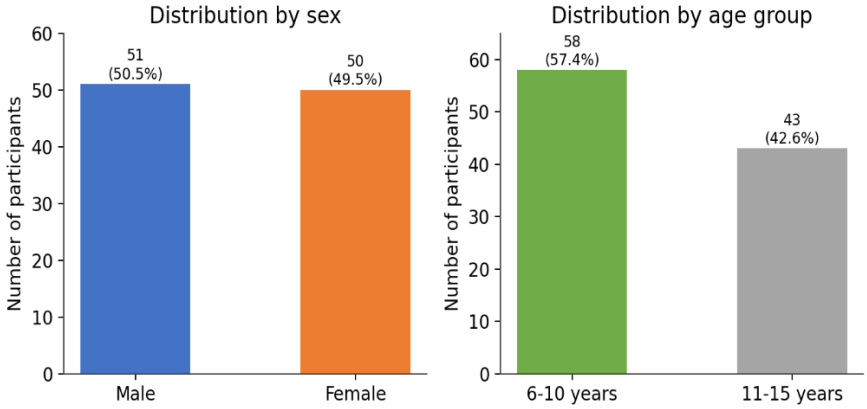

Figure (1): Distribution of study participants by sex and age group.

2. Serum TSH, T3, and T4 Concentrations:

The mean serum TSH concentration was 1.94 ± 1.516 µIU/mL among males and 2.30 ± 1.849 µIU/mL among females; the overall mean was 2.12 ± 1.691 µIU/mL and was within the laboratory reference range. The mean serum T3 concentration was 1.38 ± 0.788 nmol/L among males and 1.27 ± 0.783 nmol/L among females, with an overall mean of 1.32 ± 0.784 nmol/L. The mean serum T4 concentration was 85.80 ± 25.695 nmol/L among males and 84.73 ± 31.437 nmol/L among females, with an overall mean of 85.27 ± 28.542 nmol/L (Table 2, Figure 2).

Table (2): Mean serum TSH, T3, and T4 concentrations according to sex.

Hormone	Sex	n	Mean	SD
TSH (µIU/mL)	Male	51	1.94	1.516
	Female	50	2.30	1.849
	Total	101	2.12	1.691
T3 (nmol/L)	Male	51	1.38	0.788
	Female	50	1.27	0.783
	Total	101	1.32	0.784
T4 (nmol/L)	Male	51	85.80	25.695
	Female	50	84.73	31.437
	Total	101	85.27	28.542

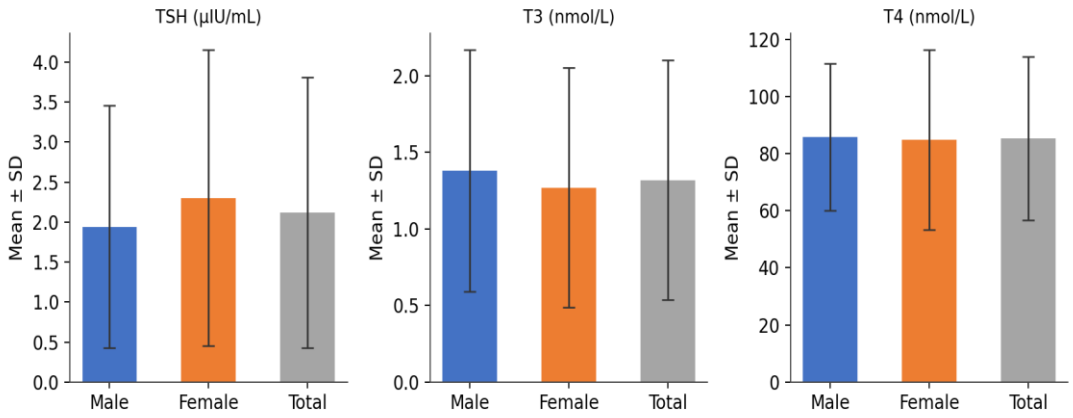

Figure (2): Mean (± SD) serum TSH, T3, and T4 concentrations by sex.

3. Distribution According to Reference Range:

Among the 101 participants, 74 (73.3%) had TSH concentrations within the reference range (0.4-4.0 µIU/mL), 11 (10.9%) had TSH above the range, and 16 (15.8%) had TSH below the range. T3 concentrations were within the reference range in 68 participants (67.3%), above it in 10 (9.9%), and below it in 23 (22.8%). T4 concentrations were within the reference range in 83 participants (82.2%) and below it in 18 (17.8%); no participant had a T4 concentration above the reference range (Table 3, Figure 3).

Table (3): Distribution of participants according to TSH, T3, and T4 reference ranges.

Hormone	Within range, n (%)	Above range, n (%)	Below range, n (%)	Total
TSH	74 (73.3)	11 (10.9)	16 (15.8)	101
T3	68 (67.3)	10 (9.9)	23 (22.8)	101
T4	83 (82.2)	0 (0.0)	18 (17.8)	101

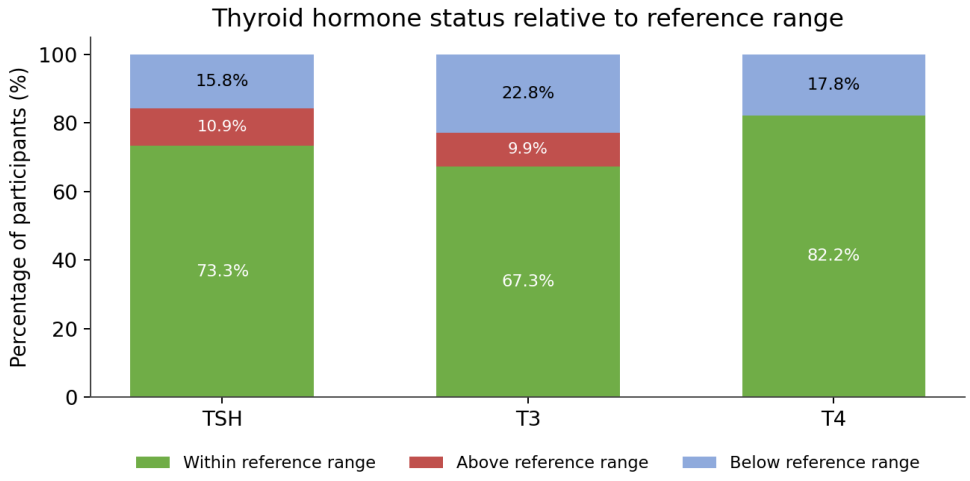

Figure (3): Thyroid hormone status (TSH, T3, T4) relative to the reference range.

4. Anthropometric Characteristics:

The anthropometric assessment included all 101 participants. The mean body weight was 33.20 ± 8.816 kg among males and 30.10 ± 6.573 kg among females, with an overall mean of 31.67 ± 7.903 kg. The mean height was 135.59 cm among males and 129.93 cm among females, with an overall mean of 132.79 cm (Table 4, Figure 4).

Table (4): Anthropometric characteristics according to sex

Variable	Male, Mean ± SD	Female, Mean ± SD	Total, Mean ± SD
Weight (kg)	33.20 ± 8.816	30.10 ± 6.573	31.67 ± 7.903
Height (cm)[a]	135.59 ± 11.331	129.93 ± 26.326	132.79 ± 20.295

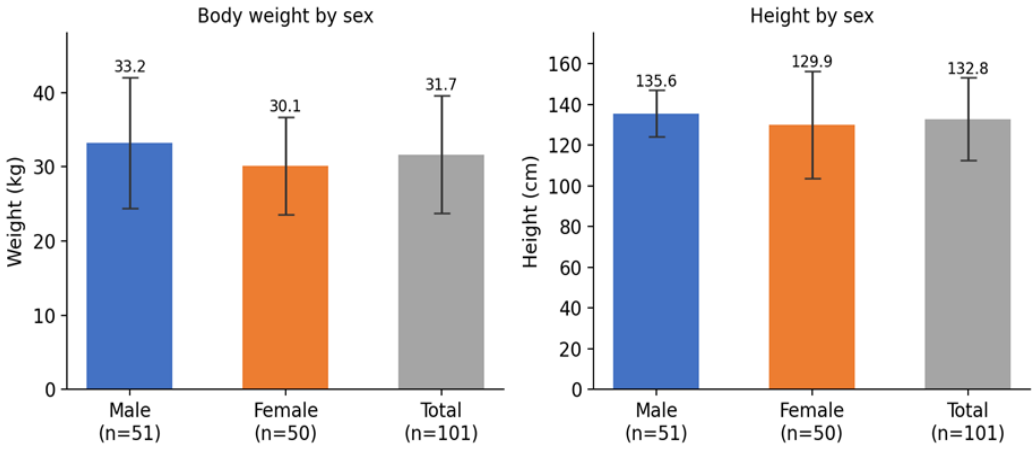

Figure (4): Mean (± SD) body weight and height by sex

5. Symptoms Potentially Associated with Hyperthyroidism:

Rapid heartbeat was the most frequently reported symptom (49 participants, 48.52%), followed by difficulty sleeping (34, 33.67%), sweating (25, 24.76%), changes in the face and eyes (9, 8.92%), tremors in the limbs (7, 6.94%), and mood changes (4, 3.97%) (Table 5, Figure 5).

Table (5): Symptoms potentially associated with hyperthyroidism.

Symptom	Yes, n	No, n	Yes, %
Changes in face and eyes	9	92	8.92
Difficulty sleeping	34	67	33.67
Sweating	25	76	24.76
Tremors in limbs	7	94	6.94
Mood changes	4	97	3.97
Rapid heartbeat	49	52	48.52

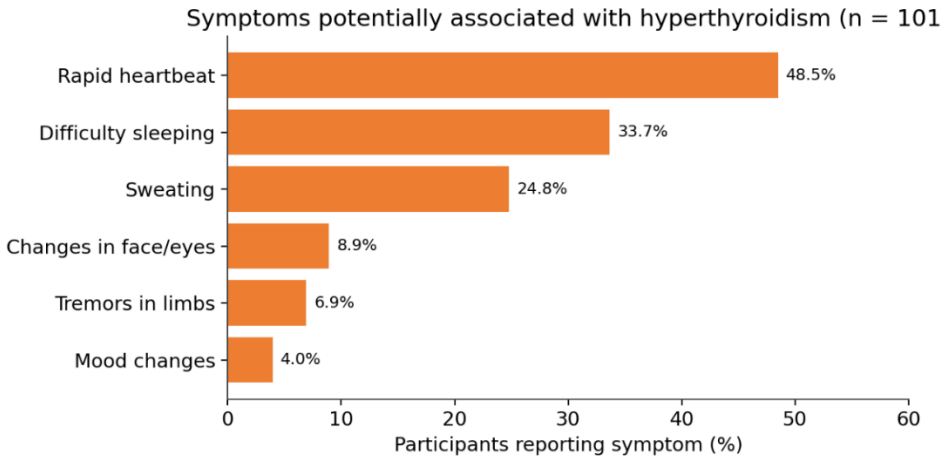

Figure (5): Symptoms potentially associated with hyperthyroidism (n = 101).

6. Symptoms Potentially Associated with Hypothyroidism:

Weight changes were reported by 56 participants (55.44%), the most frequently reported symptom in this category, followed by attention and memory problems (49, 48.52%), hair loss (40, 39.60%), growth problems (30, 29.70%), fatigue and weakness (13, 12.87%), and dry skin (10, 9.90%) (Table 6, Figure 6).

Table (6): Symptoms potentially associated with hypothyroidism.

Symptom	Yes, n	No, n	Yes, %
Fatigue and weakness	13	88	12.87
Weight changes	56	45	55.44
Dry skin	10	91	9.90
Hair loss	40	61	39.60
Growth problems	30	71	29.70
Attention and memory problems	49	52	48.52

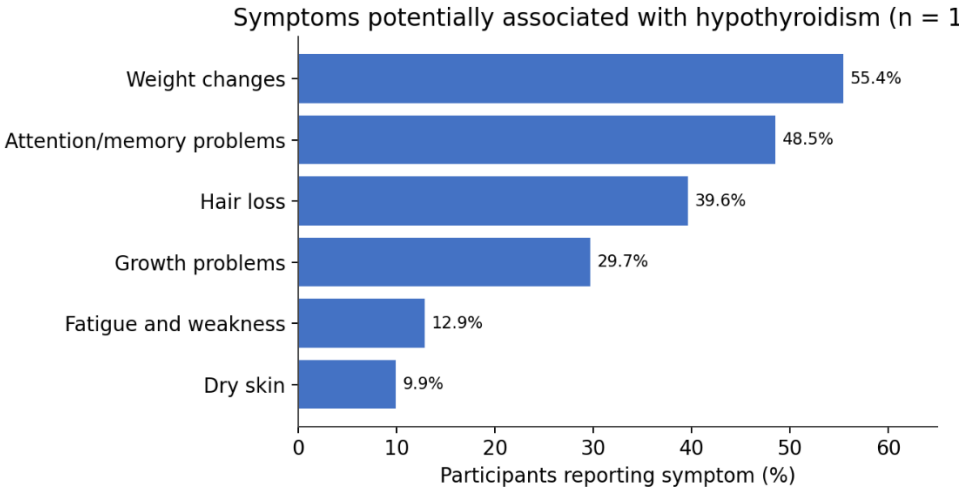

Figure (6): Symptoms potentially associated with hypothyroidism (n = 101).

7. Family History of Thyroid Disease:

A family history of thyroid disease was reported for the father in 13 participants (12.87%), the mother in 7 (6.94%), and a brother or sister in 10 (9.90%) (Table 7, Figure 7).

Table (7): **Family history of thyroid disease.**

Family member	Yes, n	No, n	Yes, %
Father	13	88	12.87
Mother	7	94	6.94
Brother/sister	10	91	9.90

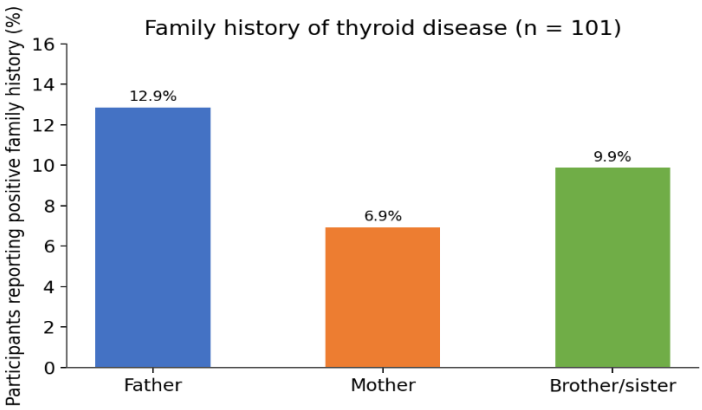

Figure (7): Family history of thyroid disease (n = 101).

Discussion:

Our study investigated the distribution of biochemical thyroid abnormalities among 101 children and adolescents aged 6–15 years in Tripoli, Western Libya. The sample was almost equally divided between males and females, while children aged 6–10 years represented the larger age group.

The overall mean TSH concentration was 2.12 ± 1.691 µIU/mL. Most participants (73.3%) had TSH values within the laboratory reference interval, while 10.9% had values above and 15.8% had values below the specified range. These findings indicate that the majority of participants had TSH concentrations within the laboratory-defined reference interval; however, the presence of biochemical values outside the reference interval in a proportion of participants suggests that thyroid-related abnormalities may occur among children and adolescents in the studied population. These findings warrant further evaluation, particularly because isolated TSH abnormalities may be transient and cannot, on their own, establish a definitive diagnosis of thyroid dysfunction.

The findings should first be interpreted alongside the only other Libyan community-based pediatric dataset available, from Tobruk. [5] That study found that 97.9% of 234 tested children and adolescents were euthyroid, with an overall thyroid dysfunction prevalence of only 2.1% — substantially lower than the 26.7% of participants with an abnormal TSH observed in the present Tripoli sample. Possible explanations for this discrepancy include differences in sample size and recruitment strategy, the specific assay platforms and reference ranges applied by each laboratory, regional variation in iodine status between Tripoli and Tobruk, and the absence of confirmatory repeat testing and thyroid antibody testing in both studies, which limits the ability to distinguish persistent, clinically meaningful dysfunction from transient or assay-related fluctuations. Given that these are, to our knowledge, the only two community-based pediatric thyroid datasets currently available from Libya, and that their prevalence estimates diverge so markedly, the true population prevalence of pediatric thyroid dysfunction in Libya cannot yet be considered established, and further multicenter Libyan studies are clearly warranted.

The findings should also be interpreted in the context of hospital-based pediatric studies from other countries. Oyenusi et al. demonstrated substantial heterogeneity in pediatric thyroid disorders in Nigeria, with congenital hypothyroidism representing a major proportion of diagnosed cases. [3] Yelluri similarly emphasized the variable etiological spectrum of thyroid disorders in children. [4] The present study differs from these investigations because it focused on biochemical thyroid measurements among children from the community rather than children already referred for thyroid disease.

The mean T3 concentration in the present study was 1.32 ± 0.784 nmol/L; T3 was within the reference range in 67.3% of participants, 22.8% had concentrations below the range, and 9.9% had concentrations above it. The mean T4 concentration was 85.27 ± 28.542 nmol/L; T4 was within the reference interval in 82.2% of participants, while 17.8% had concentrations below the specified range. These findings indicate that although most participants had T3 and T4 concentrations within the laboratory reference intervals, a proportion showed values outside the expected ranges. Such isolated biochemical findings should be interpreted cautiously, as they may reflect physiological variation or transient changes and cannot, in the absence of additional clinical and laboratory assessment, be considered diagnostic of thyroid dysfunction.

The differences in the distributions of TSH, T3, and T4 demonstrate the importance of interpreting thyroid function tests as a biochemical pattern rather than relying on one hormone measurement. TSH is particularly useful for identifying primary thyroid dysfunction, but its interpretation should be integrated with circulating thyroid hormone concentrations and the clinical context. [1]

The use of a single reference interval for all participants aged 6-15 years represents an important consideration, since thyroid hormone concentrations vary according to age, developmental stage, sex, analytical method, and population. The nationally representative US adolescent study by Chen et al. demonstrated differences in thyroid dysfunction according to age and sex and emphasized the importance of population characteristics when assessing thyroid abnormalities. [6] Similarly, a Romanian cross-sectional study by Vasile et al. evaluated thyroid function in infants and children and demonstrated the importance of age-related interpretation of thyroid biochemical parameters. [25] Accordingly, the present study reports hormone concentrations as within, above, or below the laboratory reference interval rather than assigning a definitive diagnosis to every abnormal measurement.

A high TSH concentration, for example, may be compatible with primary hypothyroidism when accompanied by an appropriately reduced thyroid hormone concentration; conversely, suppressed TSH with elevated thyroid hormones may be consistent with hyperthyroidism. However, unusual biochemical combinations may have other explanations. Gurnell et al. emphasized that apparently discordant thyroid function tests may result from assay interference, medication effects, hormone therapy, or other conditions. [13] TSH-secreting pituitary adenomas represent another rare cause of inappropriate TSH secretion. [14] These considerations reinforce the importance of evaluating the complete thyroid profile. Autoimmune thyroid disease is another important consideration in pediatric populations. Cappa et al. described Graves' disease and autoimmune thyroiditis as the two major autoimmune thyroid disorders in children and emphasized the interaction between genetic susceptibility and environmental factors. [2] The absence of thyroid peroxidase and thyroglobulin antibody measurements in the present study prevents assessment of autoimmune thyroid disease as a potential cause of the observed biochemical abnormalities.

The prevalence of thyroid dysfunction can also vary according to specific pediatric conditions. Children with Down syndrome are at increased risk of thyroid dysfunction, and recent data from Southern Saudi Arabia further demonstrate the importance of thyroid surveillance in this population. [7] However, children with Down syndrome were not specifically investigated in the present study, and the findings therefore cannot be generalized to children with genetic syndromes.

Nutritional status may also influence thyroid hormone concentrations. Calcaterra et al. reported thyroid-related biochemical alterations in children and adolescents affected by undernutrition and overnutrition. [8] Similarly, Sharmin et al. found higher TSH and FT3 and lower FT4 concentrations among obese children and adolescents in Bangladesh and identified relationships between BMI and thyroid hormone concentrations. [9] These observations highlight the importance of anthropometric assessment when studying pediatric thyroid function.

Our study included anthropometric measurements of weight and height for all 101 participants. The overall mean body weight was 31.67 ± 7.903 kg, while the mean height was 132.79 cm. Males had higher mean body weight and height than females (33.20 ± 8.816 kg vs. 30.10 ± 6.573 kg and 135.59 cm vs. 129.93 cm, respectively). These differences may reflect the normal variation in growth and body development between sexes during childhood and adolescence. However, because body weight and height are strongly influenced by age and sex, interpretation of these findings should ideally consider age-specific and sex-specific growth standards. Future studies should therefore incorporate measures such as BMI-for-age z-scores and other standardized anthropometric indicators to provide a more comprehensive assessment of growth patterns in Libyan children and adolescents.

The present study also collected symptoms potentially associated with thyroid dysfunction. Rapid heartbeat was the most frequently reported symptom potentially associated with hyperthyroidism, whereas weight change was the most frequently reported symptom potentially associated with hypothyroidism. These findings should be interpreted cautiously: symptoms such as palpitations, sweating, sleep disturbance, weight change, fatigue, and attention difficulties are nonspecific and may

result from numerous causes unrelated to thyroid disease. Therefore, their presence should not be considered evidence of thyroid dysfunction in the absence of biochemical and clinical confirmation.

The family-history findings are also relevant. A history of thyroid disease was reported in the fathers, mothers, and siblings of some participants. Family history is important because autoimmune thyroid diseases have a genetic component, although environmental factors also contribute to disease expression. [2]

The wider Libyan literature provides additional evidence that thyroid disease is an important health issue in the country. Studies conducted in Derna and the Al-Wahat region have documented thyroid disorders in Libyan populations, suggesting regional variation in thyroid disease within Libya. [17,18] A study examining awareness of thyroid disorders and iodine-rich diets in western Libyan cities also highlighted the importance of iodine and dietary practices in thyroid health, [15] and a further Libyan study emphasized the importance of iodine intake and dietary habits in thyroid health, also reporting differences between males and females in the occurrence of thyroid-related abnormalities. [16]

The relationship between thyroid dysfunction and metabolic parameters has also been investigated in Libyan adults. El Mabrouk et al. reported thyroid abnormalities among Libyan patients with type 2 diabetes mellitus, including subclinical hypothyroidism, [19] and a positive relationship between TSH and total cholesterol has been reported among Libyan patients with thyroid dysfunction, with higher cholesterol concentrations among patients with hypothyroidism. [20] These adult Libyan studies provide useful national context but cannot be directly compared with the prevalence observed in the present pediatric community sample because of differences in age, disease status, sampling strategy, and diagnostic criteria.

International studies have also demonstrated that thyroid dysfunction varies substantially between populations. A systematic review and meta-analysis found considerable variation in the prevalence of thyroid dysfunction across Middle Eastern populations, [23] supporting the need for locally generated epidemiological data in Libya. Studies in patients with type 2 diabetes mellitus internationally have similarly reported varying frequencies of thyroid dysfunction and associations with metabolic control and complications; [19,21,22] these findings are relevant to the broader epidemiology of thyroid disease but should not be interpreted as prevalence estimates for healthy children.

The present study also has relevance to the wider pediatric literature concerning thyroid function and neurodevelopment. A recent meta-analysis reported differences in several thyroid hormones and thyroid autoantibodies among children and adolescents with neurodevelopmental disorders compared with healthy controls. [24] Although neurodevelopmental disorders were not specifically assessed in the present study, this evidence emphasizes the importance of thyroid hormones during childhood and adolescence.

Thyroid carcinoma and structural thyroid disease represent another aspect of pediatric thyroid health that was not directly assessed here. Vaisman et al. reviewed thyroid carcinoma in children and adolescents and highlighted the distinctive clinical and management characteristics of pediatric thyroid cancer, [11] while a recent Polish surgical series described the indications, techniques, outcomes, and complications of thyroid surgery in children, finding that over half of children undergoing total thyroidectomy had thyroid malignancy. [12] These conditions were not specifically investigated in the present community-based study, which focused on biochemical thyroid function; however, they underscore the importance of appropriate referral pathways when significant thyroid pathology is suspected on community screening.

Reassuringly, evidence from a large German national cohort suggests that most children with subclinical or even overt thyroid dysfunction do not experience significant impairment of health-related quality of life or mental health, [10] which should be considered when counseling families of children identified with mild, asymptomatic biochemical abnormalities through community screening programs such as this one.

One important methodological consideration is that the present study measured total T3 and total T4 rather than free thyroid hormone concentrations. Modern evaluation of thyroid dysfunction commonly incorporates TSH and FT4, with FT3 used in selected clinical circumstances. The lack of FT4 limits the ability to classify participants accurately into overt and subclinical thyroid dysfunction categories.

Similarly, thyroid autoantibodies were not measured, so the study cannot determine how many participants had autoimmune thyroiditis or Graves' disease. Iodine status was also not assessed; given the importance of iodine in thyroid hormone synthesis and its documented relevance to thyroid health in Libya, [15,16] future studies should include urinary iodine concentration and detailed dietary assessment.

Another limitation is the relatively small sample size of 101 participants; the study was also restricted to Tripoli and therefore cannot be considered representative of all children in Western Libya or Libya as a whole. Nevertheless, together with the Tobruk dataset, [5] the study provides some of the only locally generated community-level information concerning thyroid hormone distributions among children and adolescents in Libya, and contributes to a still very limited pediatric thyroid literature from the country.

Conclusion and Recommendations:

The present study demonstrated that most children and adolescents aged 6-15 years in the studied population in Tripoli had TSH, T3, and T4 concentrations within the laboratory reference ranges. Nevertheless, a proportion of participants had hormone concentrations above or below the specified reference intervals, and this proportion was notably higher than in the only other available Libyan community-based pediatric dataset, from Tobruk. [5] The findings provide preliminary evidence of biochemical thyroid abnormalities among children and adolescents in Western Libya; however, abnormal values for individual thyroid hormones should not be interpreted as definitive diagnoses of hyperthyroidism or hypothyroidism without considering the complete thyroid profile and clinical context. These findings highlight three priorities for future research. Larger multicenter studies across different Libyan regions are needed, using age- and sex-specific pediatric reference intervals and standardized methods. Future studies should also include FT4, FT3 where indicated, thyroid antibodies, and urinary iodine to better identify autoimmune and iodine-related dysfunction. Finally, children with persistent biochemical abnormalities should undergo repeat confirmatory testing and clinical evaluation rather than being diagnosed based on a single measurement.

References:

1. Hong HS, Lee JY, Jeong SH. Thyroid disease in children and adolescents. Ultrasonography. 2017;36(4):287-291.
2. Cappa M, Bizzarri C, Crea F. Autoimmune thyroid diseases in children. J Thyroid Res. 2011; 2011:675703.
3. Oyenusi EE, Ajayi EO, Akeredolu FD, Oduwole AO. Pattern of thyroid disorders in children and adolescents seen at the Lagos University Teaching Hospital, Nigeria, over a 10-year period. Niger Med J. 2017;58(3):101-106.
4. Yelluri SK. Incidence and etiology of thyroid disorders in children. Int J Contemp Pediatr. 2016;3(2):593-596.
5. Hossen N, Sulayman YY, AL-Khurum KMA. Prevalence of thyroid dysfunction in children and adolescents in Tobruk City, Libya. Derna Acad J Appl Sci. 2025;5(1):25-38.
6. Chen J, Zhang L, Zhang X. Overall, sex- and race/ethnicity-specific prevalence of thyroid dysfunction in US adolescents aged 12-18 years. Front Public Health. 2024; 12:1366485.
7. Alqahtani YA, Shati AA, Alshaikh AA, Alshahrani AT, Bin Qaed SA, Alqahtani MA, et al. Prevalence, spectrum, and management of thyroid dysfunction in children with Down syndrome: a retrospective study from Southern Saudi Arabia. Children (Basel). 2025;13(1):6.
8. Calcaterra V, Magenes VC, Siccardo F, Hruby C, Basso M, Conte V, et al. Thyroid dysfunction in children and adolescents affected by undernourished and overnourished eating disorders. Front Nutr. 2023; 10:1205331.
9. Sharmin F, Chowdhury AT, Hossian M, Rafiquzzaman S, Biswas DC, Rupa FH, et al. Thyroid disorder in obese children and adolescents: a cross-sectional study in a tertiary care hospital in Bangladesh. Future. 2025;3(4):18.
10. Hirtz R, Keesen A, Hölling H, Hauffa BP, Hinney A, Grasemann C. No effect of thyroid dysfunction and autoimmunity on health-related quality of life and mental health in children and adolescents: results from a nationwide cross-sectional study. Front Endocrinol. 2020; 11:454.

11. Vaisman F, Corbo R, Vaisman M. Thyroid carcinoma in children and adolescents-systematic review of the literature. J Thyroid Res. 2011; 2011:845362.
12. Sosnowska-Sienkiewicz P, Danielewicz D, Januszkiewicz-Lewandowska D, Rusak P, Anderko I, Rzepecki M, et al. Thyroid diseases in children and adolescents requiring surgical treatment-indications, techniques, results, and complications based on 10 years of the single center's own experience. Front Endocrinol. 2024; 14:1301191.
13. Gurnell M, Halsall DJ, Chatterjee VK. What should be done when thyroid function tests do not make sense? Clin Endocrinol (Oxf). 2011; 74:673-678.
14. Beck-Peccoz P, Persani L, Mannavola D, Campi I. TSH-secreting adenomas. Best Pract Res Clin Endocrinol Metab. 2009; 23:597-606.
15. Abuhlega TA, Shtewi HH, Alhammali MM, Farhat NA, Algelani FO. The awareness of thyroid disorders and an iodine-rich diet among a sample of the population in some western cities of Libya. J Pure Appl Sci. 2024;23(2):25-33.
16. Abuagela M, Hakam A, Abd-Alwafi F, Abuhalala S. The effect of diet on the prevalence of thyroid disorder among Libyans. Alq J Med Appl Sci. 2025;8(1):476-481.
17. Bouthahab N, Almziny T, Alsharif R, Alnaas F, Bou Jazyah M, Budahab H. A study on the prevalence of thyroid disorders associated with age and sex in Derna, Libya. Derna Univ J Med Sci. 2025;3(1):21-28.
18. Matter HAB, Ayad TM, Nofal Y, Inwajy A. A prevalence of thyroid disorders at Al-Wahat region of Libya during 2022. Sci J Univ Benghazi. 2023;36(2):134-138.
19. El Mabrouk Z, Mohammed A, Mohamed F, El Jaafari H, Toumi N. Evaluation of thyroid dysfunction among Libyan patients with type-2 diabetes mellitus. Alq J Med Appl Sci. 2024;7(3):891-897.
20. Al-deib A, Eljali S, Mohamed A, Alsonosi A. Total cholesterol and thyroid-stimulating hormone levels in Libyan patients with thyroid dysfunction. Libyan Med J. 2023;15(2):43-46.
21. Sadiya S, Alam A, Monowara M, Rahman SN, Saha RR, Rana MM, et al. Clinical and biochemical profile of thyroid disorders in pediatric patients: a cross-sectional study. Int J Contemp Pediatr. 2025;12(9):1476-1481.
22. Rao PTS, Subrahmanyam K, Prasad DKV. Prevalence of subclinical hypothyroidism in children and adolescents of northern Andhra Pradesh population and its association with hyperlipidemia. Int J Res Med Sci. 2017.
23. Kargar S, Tabatabaei SM, Okati-Aliabad H, Izadi Rad H. Prevalence of thyroid dysfunction disorders among adult populations in the Middle-East: a systematic review and meta-analysis. Open Public Health J. 2024;17.
24. Wang H, Huang K, Piao L, Xue X. Dysregulation of thyroid, growth, and appetite hormones in children and adolescents with neurodevelopmental disorders: a meta-analysis. J Integr Neurosci. 2025;24(10):39816.
25. Vasile CM, Ghenea AE, Udriştoiu AL, Udriştoiu Ş, Popescu M, Padureanu V, et al. A cross-sectional study to assess thyroid function in infants and children in a city from south-western Romania. Curr Health Sci J. 2021;47(3):420-427.