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Original article

Clinical and Hormonal Characteristics of Patients with Thyroid Dysfunction in Sirte City, Libya

Khadega Alazoumi*[1], Laila Shaglouf[2]

[1]*Department of Medical Laboratory Sciences, College of Health Sciences, University of Sirte, Libya*
[2]*Department of Medical Laboratory, Faculty of Medical Technology, Elmergib University, Libya*
Corresponding Email: *khadaga.alazoumi@su.edu.ly*

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A B S T R A C T

Thyroid dysfunction is one of the most common endocrine disorders worldwide and represents a major public health concern because of its association with metabolic, cardiovascular, and systemic complications. Despite the increasing burden of thyroid diseases, epidemiological and clinical data from Libya remain limited, highlighting the need for region-specific evidence to understand the characteristics of affected patients better. This study was conducted to evaluate the demographic and clinical characteristics of patients with thyroid dysfunction and to compare thyroid hormone profiles according to thyroid disorder type, gender, and medication status among patients attending healthcare facilities in Sirte City, Libya. A cross-sectional study was conducted among 93 patients diagnosed with thyroid dysfunction. Demographic and clinical information, including age, gender, family history, chronic diseases, medication status, and thyroid hormone levels (TSH, T3, and T4), was collected. Descriptive statistics were used to summarize participant characteristics. Data normality was assessed using the Shapiro–Wilk test. Associations between categorical variables were examined using the Chi-square test, whereas comparisons of thyroid hormone levels between groups were performed using the Mann–Whitney U test. Statistical significance was established at $p < 0.05$. The mean age of the participants was 45.13 ± 17.13 years, and females constituted 71.0% of the study population. Hypothyroidism was considerably more prevalent than hyperthyroidism, accounting for 74.2% and 25.8% of cases, respectively. No statistically significant associations were identified between thyroid disorder type and age group, gender, family history, chronic disease status, or medication use (all $p > 0.05$). Thyroid hormone levels deviated significantly from a normal distribution (Shapiro–Wilk test, $p < 0.001$). Patients with hyperthyroidism had significantly higher serum T4 levels than those with hypothyroidism (median 11.20 vs. 7.32, $p < 0.001$), whereas no significant differences were observed for TSH or T3. Male patients demonstrated significantly higher TSH levels than female patients ($p = 0.004$), while T3 and T4 levels did not differ significantly according to gender. Notably, medication status was not associated with significant differences in thyroid hormone levels. Hypothyroidism was the predominant thyroid disorder and occurred predominantly among female patients. Although demographic and clinical characteristics were not significantly associated with thyroid disorder type, significant differences were identified in serum T4 according to thyroid disorder and in TSH according to gender. These findings provide region-specific evidence on thyroid dysfunction in Libya, enhance the current understanding of its clinical characteristics, and may support clinical decision-making, improve patient management, and may guide future multicenter epidemiological studies in Libya

Introduction

Thyroid dysfunction represents one of the most common endocrine disorders encountered in clinical practice. It continues to constitute a substantial global health burden because of its high prevalence, heterogeneous clinical presentation, and widespread effects on multiple organ systems [1,2,3]. Thyroid hormones are essential regulators of metabolic homeostasis and play fundamental roles in growth, thermogenesis, cardiovascular performance, neurological development, reproduction, and cellular energy metabolism. Consequently, disturbances in thyroid hormone synthesis, secretion, or action may adversely affect virtually every tissue, resulting in clinical manifestations that range from mild nonspecific symptoms to severe metabolic, cardiovascular, neuropsychiatric, and reproductive complications [4].

Owing to the often-insidious onset and nonspecific nature of thyroid disorders, biochemical assessment has become indispensable for accurate diagnosis and appropriate clinical management. Measurement of thyroid-stimulating hormone (TSH), together with triiodothyronine (T3) and thyroxine (T4), remains the cornerstone of thyroid function assessment, providing objective information for disease diagnosis, classification, therapeutic monitoring, and long-term follow-up [1,2,5]. Despite considerable advances in diagnostic techniques and disease management, thyroid dysfunction continues to impose a significant healthcare burden worldwide, with marked geographical variation influenced by iodine

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nutrition, demographic characteristics, environmental exposures, and healthcare accessibility [2,3]. Given the broad physiological functions of thyroid hormones, disturbances in thyroid function may manifest as two major clinical disorders with distinct biochemical and clinical characteristics. These disorders differ considerably in their underlying pathophysiology and clinical manifestations.

Thyroid dysfunction primarily comprises hypothyroidism and hyperthyroidism, two disorders with distinct pathophysiological mechanisms but equally important clinical consequences. Hypothyroidism is characterized by inadequate synthesis or secretion of thyroid hormones, resulting in generalized slowing of metabolic processes and manifestations including fatigue, weight gain, cold intolerance, constipation, menstrual irregularities, dyslipidaemia, cognitive impairment, and reduced quality of life. In contrast, hyperthyroidism results from excessive thyroid hormone production, leading to increased metabolic activity characterized by weight loss, heat intolerance, tremor, palpitations, anxiety, muscle weakness, and an increased risk of cardiac arrhythmias and other cardiovascular complications [1,6,7]. Although these disorders differ in their biochemical profiles and clinical presentation, both are associated with considerable morbidity and may adversely affect multiple organ systems if diagnosis is delayed or treatment is inadequate. Moreover, alterations in thyroid hormone concentrations have been associated with abnormalities in lipid metabolism, glucose homeostasis, bone turnover, and cardiovascular function, highlighting the importance of timely diagnosis and appropriate therapeutic intervention [1,7-9]. Thus, accurate interpretation of thyroid function tests should not rely solely on biochemical measurements but should be integrated with clinical findings to ensure appropriate diagnosis, classification, and long-term management of affected patients. Thus, increasing attention has been directed toward identifying the demographic and clinical factors that may influence thyroid hormone profiles and disease presentation among affected patients.

Accumulating evidence indicates that the clinical presentation and biochemical profile of thyroid dysfunction are influenced by a complex interaction of demographic characteristics, genetic predisposition, comorbid diseases, and treatment-related factors rather than by thyroid hormone abnormalities alone [2,7-9]. Age is considered one of the principal determinants of thyroid function, as physiological changes accompanying aging may alter thyroid hormone metabolism and contribute to an increased prevalence of thyroid dysfunction, particularly hypothyroidism, among older adults [2]. Sex also plays a pivotal role, with women consistently demonstrating a substantially higher lifetime risk of thyroid disorders than men, largely because of hormonal influences, immune modulation, and the greater susceptibility of females to autoimmune thyroid diseases [10,11]. In addition, thyroid dysfunction frequently coexists with chronic conditions such as diabetes mellitus and hypertension. Thyroid hormones are closely involved in glucose metabolism, insulin sensitivity, endothelial function, vascular resistance, and cardiovascular regulation, suggesting that disturbances in thyroid function may influence the development, progression, or clinical outcomes of these disorders [7,8]. In addition, family history remains an established risk factor reflecting the contribution of genetic and autoimmune mechanisms to thyroid disease susceptibility, whereas ongoing thyroid-specific treatment may substantially modify circulating concentrations of TSH, T3, and T4, thereby influencing the biochemical profile observed during clinical assessment [11,12]. Although these factors have been extensively investigated, their relative contribution to thyroid dysfunction remains inconsistent across different populations, highlighting the need for further population-specific research.

Despite these advances, important gaps remain in the current understanding of the demographic, clinical, and hormonal characteristics of patients with thyroid dysfunction, particularly in underrepresented populations. Most previous studies have primarily focused on the prevalence of thyroid disorders, autoimmune thyroid disease, or isolated biochemical abnormalities, whereas comparatively fewer investigations have comprehensively evaluated the combined demographic characteristics, clinical profile, thyroid hormone patterns, treatment status, and associated comorbidities within the same patient population [2,7,13]. Likewise, published findings regarding the influence of age, sex, diabetes mellitus, hypertension, and family history on thyroid hormone concentrations have not always been consistent, reflecting differences in study design, population characteristics, iodine status, healthcare systems, and laboratory methodologies across different countries [2,7]. Evidence from North Africa, particularly Libya, remains notably limited despite the increasing clinical burden of thyroid disorders and the growing demand for region-specific epidemiological and laboratory data. Accordingly, the absence of locally generated evidence restricts comprehensive understanding of the demographic and clinical characteristics of patients with thyroid dysfunction and limits meaningful comparisons with findings reported from other populations. These limitations underscore the importance of generating locally relevant evidence that may improve understanding of thyroid dysfunction and support evidence-based clinical practice in different healthcare settings.

In light of these considerations, the current study was undertaken to characterize the demographic, clinical, and hormonal profile of patients with thyroid dysfunction attending healthcare laboratories in Sirte City, Libya. Specifically, the study evaluated the distribution of thyroid dysfunction according to age and sex, assessed thyroid hormone concentrations (TSH, T3, and T4), and investigated their relationships with diabetes mellitus, hypertension, family history, and medication status. By integrating biochemical findings with demographic and clinical characteristics, this study provides region-specific evidence that may contribute to improving the clinical evaluation and management of thyroid dysfunction and provide a basis for future multicenter studies on thyroid dysfunction in Libya.

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Methodology

Study design and data collection

This descriptive cross-sectional laboratory-based study included 93 participants diagnosed with thyroid dysfunction. Data were collected using a structured questionnaire combined with laboratory evaluation of thyroid function tests from different laboratories in Sirte City, Libya. The collected variables included age, gender, serum TSH, T3, and T4 levels, family history of thyroid disease, diabetes mellitus, hypertension, and other chronic diseases. Thyroid function status was classified according to the reference ranges adopted by the participating laboratories.

Study Population

Participants were recruited from different medical laboratories in Sirte City, Libya, between January 2026 and April 2026. Patients with previously diagnosed thyroid dysfunction who attended the participating laboratories during the study period were selected using a convenience sampling method.

Inclusion Criteria

- Patients diagnosed with hypothyroidism or hyperthyroidism.
- Availability of thyroid function test results (TSH, T3, and T4).
- Patients who agreed to provide the required information.

Exclusion Criteria

- Patients with incomplete laboratory records.
- Pregnant women.
- Patients with severe systemic diseases affecting thyroid hormone levels.
- Individuals with missing demographic or clinical information.

Ethical Considerations

This study was conducted using data obtained from medical records and a structured questionnaire. Written informed consent was obtained from participants who completed the questionnaire. All patient data were anonymized before analysis, and strict confidentiality was maintained throughout the study. Personal identifiers were removed to protect participants' privacy, and the collected data were used solely for research purposes.

Statistical Analysis

Statistical analysis was performed using JASP software (Version 0.19). Descriptive statistics were used to summarize the demographic, clinical, and laboratory characteristics of the study population. Continuous variables were assessed for normality using the Shapiro–Wilk test. Normally distributed data were expressed as mean ± standard deviation (SD), whereas non-normally distributed data were presented as median and interquartile range (IQR). Categorical variables were summarized as frequencies and percentages.

Associations between categorical variables and thyroid disorder type were evaluated using the Chi-square test. Since thyroid hormone levels (TSH, T3, and T4) were not normally distributed, comparisons between two independent groups were performed using the Mann–Whitney U test. Comparisons were conducted according to thyroid disorder type (hypothyroidism versus hyperthyroidism), gender (male versus female), and medication status (receiving medication versus not receiving medication). All statistical tests were two-tailed, and a p-value < 0.05 was considered statistically significant.

Results

Demographic and Clinical Characteristics

A total of 93 patients with thyroid dysfunction were included in this study. The mean age of the participants was 45.13 ± 17.13 years. Females comprised the majority of the study population (66, 71.0%), while males accounted for 27 (29.0%). Hypothyroidism was more prevalent than hyperthyroidism, affecting 69 (74.2%) and 24 (25.8%) patients, respectively. Most participants (72.0%) were receiving treatment, and more than half (56.9%) had no chronic diseases. Diabetes mellitus, hypertension, and both conditions together were reported in the remaining patients. The demographic and clinical characteristics of the study population are summarized in (Table 1).

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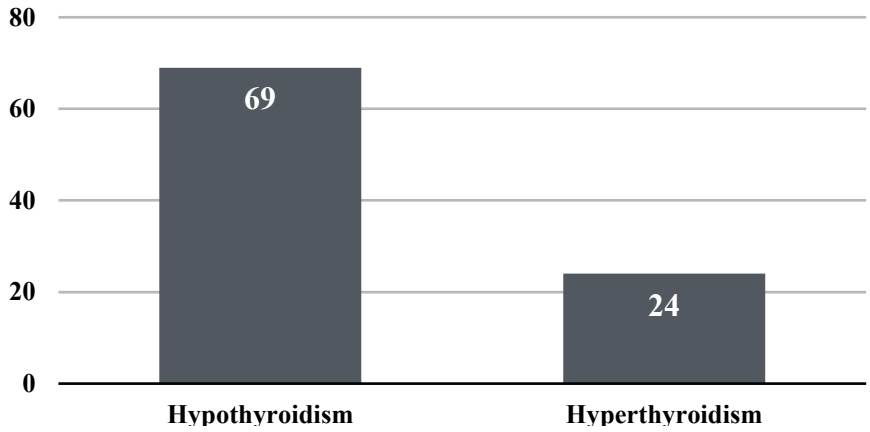

Figure 1. Distribution of patients according to thyroid disorder.

Table 1. Demographic and Clinical Characteristics of the Study Population

Variable		Value
Age (years), Mean±SD		45.130 17.125
Female n (%)		66 (71.0 %)
Male n (%)		27 (29.0 %)
Hyperthyroidism n (%)		24 (25.8 %)
Hypothyroidism n (%)		69 (74.2 %)
Family history present n (%)		21 (22.6 %)
Medicating n (%)	Yes	67 (72 %)
	No	26 (28 %)
Chronic diseases present n (%)	Diabetes	21 (22.6 %)
	Hypertension	13 (13.9 %)
	Diabetes and Hypertension	6 (6.5 %)
	No chronic disease	53 (56.9 %)

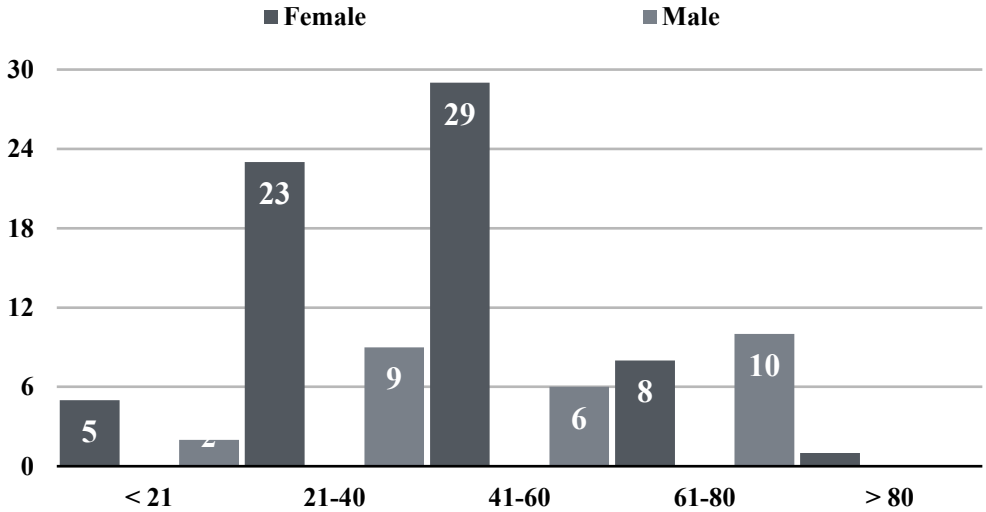

Figure 2. Distribution of study participants according to age group and gender

Association between Participants' Characteristics and Thyroid Disorder

The association between thyroid disorder type and demographic and clinical characteristics was assessed using the Chi-square test. No statistically significant associations were observed between thyroid disorder type and age group (p = 0.341), gender (p = 0.590), family history (p = 0.084), chronic disease status (p = 0.606), or medication use (p = 0.708) (Table 2).

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Table 2. Association Between Demographic and Clinical Variables and Thyroid Disorder.

Variable	χ^2	df	P-value
Age group	4.516	4	0.341
Gender	0.290	1	0.590
Family history	0.345	2	0.084
Chronic diseases	1.003	2	0.606
Medicating	0.140	1	0.708

Descriptive Statistics and Normality Assessment of Thyroid Hormones

Descriptive statistics for thyroid hormone levels are presented in (Table 3). The median (IQR) values were 5.00 (8.70) for TSH, 1.18 (1.30) for T3, and 8.00 (5.50) for T4. The Shapiro–Wilk test demonstrated that the distributions of all three hormone levels significantly deviated from normality ($p < 0.001$), indicating that non-parametric statistical tests were appropriate for subsequent analyses.

Table 3. Descriptive Statistics and Normality Assessment of Thyroid Hormones.

Variable	Median (IQR)	Mean ± SD	Min—Max	Shapiro- Wilk (W)	P-value
TSH	5.00 (8.70)	10.20 17.03	0.02–94.00	0.576	< 0.001
T3	1.18 (1.30)	2.31 3.30	0.28–24.00	0.513	< 0.001
T4	8.00 (5.50)	9.66 10.64	0.10–72.00	0.569	< 0.001

Comparison of Thyroid Hormone Levels According to Thyroid Disorder

Thyroid hormone levels were compared between patients with hyperthyroidism and hypothyroidism using the Mann–Whitney U test. Serum T4 levels were significantly higher among patients with hyperthyroidism than those with hypothyroidism (median 11.20 [IQR 4.05] vs. 7.32 [IQR 5.68], U = 1248.5, $p < 0.001$). However, no statistically significant differences were observed for TSH (U = 641.5, $p = 0.102$) or T3 (U = 1008.0, $p = 0.115$) (Table 4).

Table 4. Comparison of Thyroid Hormone Levels According to Thyroid Disorder.

Variable	Hyperthyroidism Median (IQR)	Hypothyroidism Median (IQR)	Mann-Whitney U	P-value
TSH	1.730 (9.62)	5.023 (7.73)	641.50	0.102
T3	1.320 (2.06)	1.110 (1.17)	1008.00	0.115
T4	11.200 (4.05)	7.320 (5.68)	1248.50	< .001

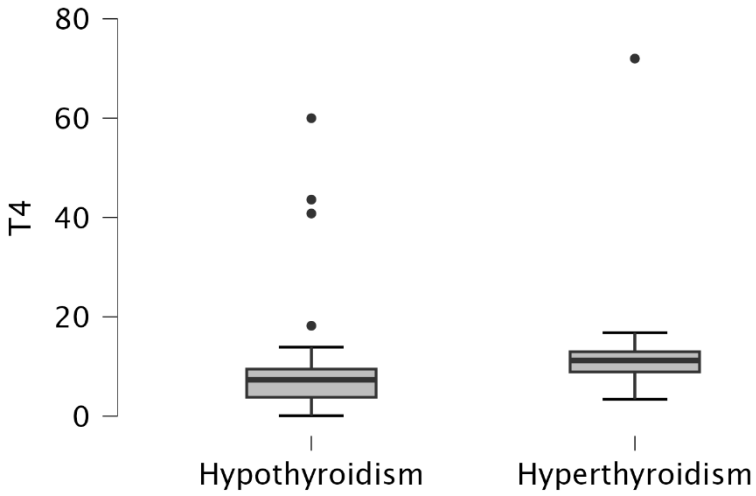

Figure 3. Boxplot showing T4 levels according to thyroid disorder.
The horizontal line represents the median, the box indicates the interquartile range, and the whiskers represent the data dispersion.

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Comparison of Thyroid Hormone Levels According to Gender

Thyroid hormone levels were also compared between male and female patients using the Mann–Whitney U test. A statistically significant difference was observed in TSH levels, with males showing higher values than females (U = 546.0, p = 0.004). In contrast, no significant differences were found in T3 (U = 677.5, p = 0.071) or T4 (U = 788.0, p = 0.386) between the two groups (Table 5).

Table 5. Comparison of Thyroid Hormone Levels According to Gender

Variable	Gender Median (IQR)		Mann-Whitney U	P-value
	Female	Male		
TSH	4.065 (5.95)	7.930 (9.15)	546.00	0.004
T3	1.060 (1.44)	1.600 (0.91)	677.50	0.071
T4	7.860 (6.99)	8.670 (5.11)	788.00	0.386

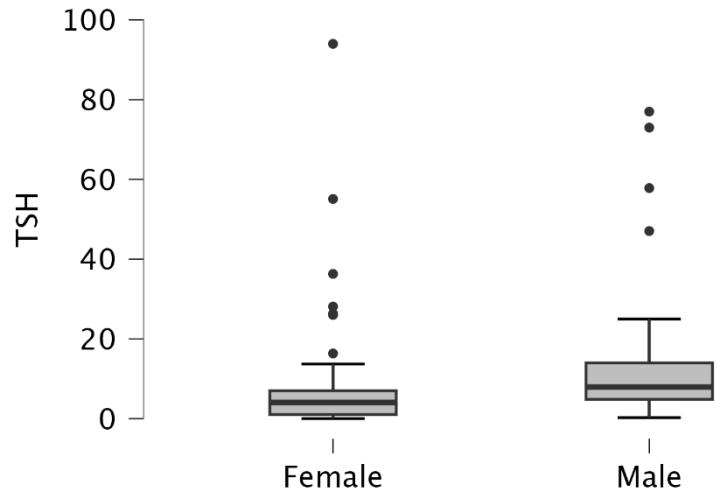

Figure 4. Boxplot showing TSH levels according to gender.
The horizontal line represents the median, the box indicates the interquartile range, and the whiskers represent the data dispersion.

Comparison of Thyroid Hormone Levels According to Medication Status

The comparison of thyroid hormone levels according to medication status is presented in (Table 6). No statistically significant differences were observed in TSH, T3, or T4 levels between patients receiving medication and those not receiving medication (all p > 0.05).

Table 6. Comparison of Thyroid Hormone Levels According to Medication

Variable	Medication Median (IQR)		Mann-Whitney U	P-value
	No	Yes		
TSH	5.720 (6.23)	4.290 (8.43)	1010.50	0.234
T3	1.290 (1.61)	1.160 (1.24)	999.00	0.273
T4	8.335 (5.13)	8.000 (6.56)	976.50	0.369

Discussion

The present study provides a comprehensive description of the demographic, clinical, and hormonal characteristics of patients with thyroid dysfunction in Sirte City, Libya. The findings demonstrated that hypothyroidism was the predominant thyroid disorder, serum T4 differed significantly between thyroid disorder groups, whereas demographic and clinical characteristics were not significantly associated with thyroid disorder type. These findings warrant further interpretation in the context of previous epidemiological and clinical evidence.

One of the most important findings of this study was the predominance of hypothyroidism, which accounted for approximately three-quarters of all diagnosed cases. This finding is consistent with previous epidemiological studies reporting that hypothyroidism is generally more prevalent than hyperthyroidism, particularly among women and middle-aged adults [1,4,12,14]. Taylor et al. identified hypothyroidism as one of the most common endocrine disorders worldwide

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[2], while Chiovato et al. emphasised that autoimmune thyroiditis remains the leading cause of primary hypothyroidism in iodine-sufficient populations [14]. Likewise, international clinical guidelines recognize hypothyroidism as the thyroid disorder most frequently encountered in routine clinical practice and highlight the importance of early diagnosis and appropriate management [12]. Although the reported prevalence of hypothyroidism varies considerably among studies, these differences are largely attributable to variations in study design, population characteristics, iodine intake, ethnicity, healthcare accessibility, and screening practices [2,4,14]. Hospital-based studies, such as the present investigation, generally report a higher prevalence than community-based surveys because they include symptomatic individuals seeking medical care rather than the general population. Consequently, the predominance of hypothyroidism observed in this study should be interpreted within the context of a hospital-based cohort rather than as an estimate of population prevalence.

From a clinical perspective, hypothyroidism frequently develops gradually and presents with nonspecific manifestations such as fatigue, weight gain, constipation, cold intolerance, menstrual disturbances, and cognitive impairment, which may delay diagnosis if thyroid function testing is not performed [12,14]. Therefore, early biochemical assessment remains essential for timely diagnosis and appropriate treatment. Notably, the investigation contributes valuable regional evidence from Libya, where epidemiological data on thyroid disorders remain scarce, and provides baseline information that may support future multicenter studies and improve thyroid disease surveillance. This emphasises the importance of early laboratory screening, particularly in patients presenting with vague or nonspecific symptoms.

A further methodological finding was that serum TSH, T3, and T4 concentrations were not normally distributed according to the Shapiro–Wilk test. This observation is consistent with previous reports indicating that endocrine biomarkers commonly exhibit skewed distributions because of physiological regulation, disease severity, treatment status, and individual biological variability [15-17]. Accordingly, the use of the Mann–Whitney U test represented an appropriate statistical approach and strengthened the validity of the comparative analyses performed in the current study [16,17].

A principal finding of the present study was the significantly higher serum T4 concentration in patients with hyperthyroidism compared with those with hypothyroidism, whereas no significant differences were observed for TSH or T3. This finding is biologically plausible because thyroxine (T4) is the major hormone secreted by the thyroid gland and plays a central role in differentiating hyperthyroid from hypothyroid states [12,18,19]. Accordingly, the observed increase in T4 among patients with hyperthyroidism and its reduction among those with hypothyroidism are consistent with the established pathophysiology of thyroid disease and support the biochemical classification of the study participants.

These findings are consistent with previous clinical studies and current international guidelines, which recommend combined assessment of serum TSH and free T4 for the diagnosis and evaluation of thyroid dysfunction [6,7,12,17,18]. The significant difference observed in serum T4 therefore reinforces its diagnostic value and highlights its importance in routine endocrine practice.

In contrast, serum TSH and T3 did not differ significantly between thyroid disorder groups. This observation may be explained by the high proportion of treated patients in the investigation, as approximately 72% were receiving therapy at the time of data collection. Appropriate treatment aims to restore euthyroidism and reduce hormonal variation, thereby diminishing biochemical differences that may be evident before treatment [4,12]. Furthermore, because a substantial proportion of circulating T3 is produced through peripheral conversion of T4 rather than direct thyroid secretion, serum T3 may remain within the reference range despite significant thyroid dysfunction, particularly in treated patients or those with mild disease [12,18,20].

The retrospective design of the current study also limited the availability of important treatment-related variables, including treatment duration, medication adherence, dosage adjustment, therapeutic response, and timing of blood sampling, all of which may influence circulating hormone concentrations [4,20]. Therefore, the absence of statistically significant differences in TSH and T3 should be interpreted cautiously and does not diminish their established clinical importance. Rather, the present findings emphasize that thyroid function tests should always be interpreted alongside clinical presentation, treatment history, and other laboratory findings to ensure accurate diagnosis and appropriate patient management, in accordance with current endocrine guidelines [12,19].

Likewise, the present study demonstrated that the TSH concentration was significantly higher in male participants compared with females, whereas no significant gender-related differences were identified for T3 or T4. Although thyroid disorders are generally more common among women, previous studies have shown that circulating thyroid hormone concentrations do not necessarily differ between the sexes, particularly among treated patients or those with established thyroid disease [11,21-24]. The higher TSH levels observed in males may reflect physiological variation within the hypothalamic–pituitary–thyroid axis rather than differences in circulating thyroid hormone concentrations. Moreover, TSH is influenced by several factors, including age, body mass index, circadian rhythm, iodine intake, smoking, and medication use, many of which could not be evaluated in the present retrospective study [21,25]. Therefore, this finding should be interpreted cautiously and not be attributed solely to biological sex.

Despite the observed difference in TSH concentrations, gender was not significantly associated with thyroid disorder type. This suggests that although biochemical variation may exist between males and females, it was insufficient to influence the overall distribution of hypothyroidism and hyperthyroidism within the study population. Similar findings have been

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reported in hospital-based studies, where treatment and disease management tend to reduce biochemical variation between patient groups [22,24].

The investigation also found no significant association between age group and thyroid disorder type, despite the highest proportion of patients being within the 41–60-year age group [26]. This observation differs from population-based studies reporting an increasing prevalence of hypothyroidism with advancing age [1,2,26]. However, the comparison performed in the current study involved only patients with established thyroid dysfunction and therefore examined differences between hypothyroidism and hyperthyroidism rather than the overall risk of developing thyroid disease. Accordingly, the absence of statistical significance does not indicate that age is unrelated to thyroid dysfunction but rather that age alone did not differentiate thyroid disorder type within this hospital-based cohort.

Several methodological factors may also explain this finding. The relatively small sample size and subdivision into multiple age categories reduced statistical power, while categorizing age rather than analysing it as a continuous variable may have obscured subtle age-related trends [26,27]. In addition, important variables such as disease duration, menopausal status, nutritional status, and long-term treatment history were unavailable because of the retrospective study design.

No statistically significant associations were observed between thyroid disorder type and diabetes mellitus or hypertension. Although both conditions frequently coexist with thyroid dysfunction and have been associated with alterations in thyroid physiology, previous studies suggest that their relationship is influenced by multiple factors, including disease duration, metabolic control, obesity, cardiovascular risk factors, and treatment status [7,28-34]. Since these variables were unavailable in the present study, residual confounding cannot be excluded. Therefore, the current findings indicate that diabetes mellitus and hypertension were not independent determinants of thyroid disorder type within the present cohort.

Similarly, family history was not significantly associated with thyroid disorder type. Although genetic susceptibility plays an important role in autoimmune thyroid disease, current evidence indicates that disease development depends on complex interactions between genetic predisposition and environmental factors, including iodine intake, smoking, immune regulation, infections, and other environmental exposures [13,35-37]. In addition, family history was obtained from routine medical records and patient reports, making it susceptible to incomplete documentation and recall bias [38]. Thus, the absence of a significant association should not be interpreted as evidence against familial susceptibility but rather as indicating that family history alone was insufficient to distinguish hypothyroidism from hyperthyroidism in this study population.

No significant differences in thyroid hormone levels were observed according to medication status. Although this finding may initially appear unexpected, it is consistent with the primary objective of thyroid disease treatment, which is to restore euthyroidism and normalize circulating thyroid hormone concentrations [2,4,6,12]. Because approximately 72% of participants were receiving treatment at the time of data collection, therapy may have reduced measurable hormonal differences between groups. In addition, important treatment-related variables, including treatment duration, medication adherence, dosage adjustment, and therapeutic response, were unavailable because of the retrospective study design. Consequently, medication status alone should not be considered an independent determinant of thyroid hormone concentrations in the current study.

Overall, the findings highlight the multifactorial nature of thyroid dysfunction. Although serum T4 clearly differentiated patients with hypothyroidism and hyperthyroidism, most demographic and clinical characteristics, including age, chronic diseases, family history, and medication status, were not independently associated with thyroid disorder type. These observations support current evidence indicating that thyroid dysfunction results from complex interactions among genetic, immunological, endocrine, metabolic, and environmental factors rather than from a single clinical determinant [1,2,24].

An important strength of the investtigation is the use of an appropriate statistical approach based on formal assessment of data normality before selecting comparative tests. By applying non-parametric analyses that reflected the characteristics of the biochemical variables, the validity of the statistical findings was strengthened [16,17]. Furthermore, this study provides valuable baseline data describing the demographic, clinical, and biochemical characteristics of thyroid dysfunction in Sirte City, contributing evidence from a region where published data remain limited.

Nevertheless, several limitations should be acknowledged. The retrospective cross-sectional design precludes causal inference, and the study was conducted in healthcare facilities within a single city, which may limit the generalizability of the findings [39]. In addition, several potentially influential variables, including thyroid autoantibody status, iodine intake, body mass index, smoking habits, disease duration, treatment adherence, medication dosage, and menopausal status, were unavailable and therefore could not be incorporated into the analyses [2,11]. The relatively small sample size may also have limited the statistical power to detect weaker associations.

Despite these limitations, the study contributes meaningful evidence regarding thyroid dysfunction in the Libyan population. Importantly, the absence of statistically significant associations for several variables should not be regarded as a weakness but rather as an objective reflection of the analyzed data, providing balanced evidence that may support future systematic reviews and multicenter investigations [40].

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From a clinical perspective, the findings emphasize that accurate evaluation of thyroid dysfunction should rely primarily on comprehensive biochemical assessment integrated with clinical history, physical examination, and treatment status rather than on demographic characteristics alone. Future multicenter prospective studies incorporating thyroid autoantibodies, iodine status, metabolic indicators, and long-term follow-up are recommended to improve understanding of thyroid dysfunction and support evidence-based strategies for diagnosis and management in Libya.

Conflict of interest. Nil

Conclusion

Hypothyroidism was the predominant thyroid disorder and occurred predominantly among female patients. Although demographic and clinical characteristics were not significantly associated with thyroid disorder type, significant differences were identified in serum T4 according to thyroid disorder and in TSH according to gender. These findings provide region-specific evidence on thyroid dysfunction in Libya, enhance the current understanding of its clinical characteristics, and may guide future multicenter studies to improve the diagnosis and management of thyroid disorders in the Libyan population.

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