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*Original article*

# The Relationship between Thyroid-Stimulating Hormone Levels and Anaemia Parameters: A Cross-Sectional Study in Misurata, Libya

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**ABSTRACT**

Thyroid dysfunction and anaemia are common conditions that frequently co-occur, yet data from Libya on their association remain scarce. This study aimed to evaluate the relationship between Thyroid-Stimulating Hormone (TSH) levels and anaemia parameters among patients attending endocrinology clinics in Misurata, Libya. A cross-sectional study was conducted on 100 consecutive participants (17 males, 83 females) recruited between September 2025 and April 2026. Complete blood counts (CBC) and serum TSH levels were measured using automated analysers. Participants were classified based on TSH levels and haemoglobin concentrations. Statistical analyses included independent t-tests and Pearson's correlation coefficient. Among the cohort, 35% had isolated anaemia, 22% had hypothyroidism (elevated TSH) coexisting with anaemia, and 10% had thyroid dysfunction with anaemia. Females constituted 83% of participants. A statistically significant inverse correlation was observed between TSH and haemoglobin levels in the hypothyroidism-with-anaemia group ($r = -0.484$, 95% CI [-0.750, -0.082], exact $P = 0.022$), indicating that higher TSH levels were associated with lower haemoglobin concentrations. Mean haemoglobin was significantly lower in patients with elevated TSH (9.93 ± 1.48 g/dL) compared to euthyroid controls (13.14 ± 1.15 g/dL). This study demonstrates a significant association between elevated TSH levels and reduced haemoglobin concentrations in the Libyan population studied. The findings support the consideration of thyroid function screening in the diagnostic evaluation of unexplained anaemia.

## Introduction

The thyroid gland is a key endocrine organ that regulates basal metabolic rate, oxygen consumption, and energy homeostasis [1]. Thyroid function is primarily assessed through measurement of Thyroid-Stimulating Hormone (TSH), which is the most sensitive first-line screening marker for thyroid dysfunction. TSH is secreted by the anterior pituitary and regulates the production of thyroid hormones through a negative feedback mechanism within the hypothalamic-pituitary-thyroid (HPT) axis which in turn drives cellular oxygen consumption and ATP generation [2, 3]. Anaemia is a widespread haematological disorder, particularly prevalent in low- and middle-income countries. The World Health Organization (WHO) identifies iron deficiency as the leading cause, especially among women of reproductive age. Anaemia results from reduced haemoglobin concentration or red blood cell mass, limiting oxygen delivery to tissues. Its causes are diverse, including nutritional deficits, chronic diseases, hereditary conditions, and blood loss [4]. Thyroid hormones play a direct role in erythropoiesis by stimulating erythroid progenitor cells in the bone marrow, enhancing intestinal iron absorption, and regulating erythropoietin production [5, 6]. Elevated TSH levels, indicative of hypothyroidism, have been associated with reduced haemoglobin and altered red cell indices in several populations [7,8]. In Libya, specific data linking TSH levels with anaemia parameters are limited. Existing regional studies have primarily focused on thyroid function in specific demographic subsets, or associations with diabetes markers within the Libyan population [9]. This study was designed to address this gap by evaluating the relationship between TSH levels and anaemia markers (haemoglobin, RBC count, and MCV) in a cohort from Misurata, Libya.

## Materials and Methods

### *Study Design and Setting*

This cross-sectional analytical study was conducted at the Misurata Medical Centre and the Specialized Centre for Diabetes and Endocrinology in Misurata, Libya, between September 15, 2025, and April 5, 2026. The study protocol was approved by the Institutional Review Board of Misurata University on May 12, 2025 (Approval No. 1569/2025).


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***Participants***
A total of 100 consecutive participants (17 males and 83 females) were recruited from patients attending the aforementioned centres. Written informed consent was obtained from all participants prior to enrolment. The high proportion of females (83%) reflects the demographic typically seeking care at specialized endocrinology centres.

***Inclusion and Exclusion Criteria***
Participants were included if they were adults attending the study centres during the recruitment period. Exclusion criteria included pregnancy, known thalassemia or other haemoglobinopathies, active bleeding, recent blood transfusion, and use of medications known to affect thyroid function or haematological parameters.

***Sample Collection and Laboratory Analysis***
Two blood samples were collected from each participant: Sample 1 (EDTA Tube): 2 mL of whole blood was used for Complete Blood Count (CBC) analysis using a Medonic M51 Haematology Analyzer. Parameters measured included Haemoglobin (HGB), Red Blood Cell count (RBC), White Blood Cell count (WBC), and Mean Corpuscular Volume (MCV).
Sample 2 (Plain Tube): Serum was obtained via centrifugation (4000 RPM for 5 minutes). TSH was measured using a Mindray CL-1200i Chemiluminescence Immunoassay Analyzer.

***Note on Hormone Measurements***
While total T3 and T4 were initially measured as part of the thyroid function panel, these values were excluded from the final statistical analysis due to identified inconsistencies in assay units and reference ranges within the dataset. TSH was retained as the primary thyroid marker, as it is the most sensitive and reliable indicator of thyroid dysfunction and is recommended as the first-line screening test by major endocrine societies.

***Group Classification***
Participants were classified into six distinct groups based on precise TSH levels and haematological parameters, utilizing standard laboratory reference ranges (TSH normal range: 0.4–4.5 mIU/L):
Isolated Anaemia (Macrocytic): Normal TSH, reduced HGB, and elevated MCV (n=35).
Hypothyroidism Only: Elevated TSH (>4.5 mIU/L) with normal HGB (n=10).
Euthyroid with Low-Normal TSH: Low-normal TSH (0.4–1.0 mIU/L) with normal HGB (n=10).
Hypothyroidism with Anaemia (Microcytic): Elevated TSH (>4.5 mIU/L) with reduced HGB and low MCV (n=22).
Euthyroid with Normocytic Anaemia: Normal TSH, reduced HGB, and normal MCV (n=10).
Euthyroid Non-Anaemic Control: Normal TSH and normal HGB (n=13).

***Statistical Analysis***
Data were analysed using SPSS software (Version 26.0, IBM Corp.). Descriptive statistics were presented as mean ± standard deviation (SD). Independent samples t-tests were used for pairwise comparisons between groups and the control group. Pearson's correlation coefficient was used to assess linear relationships between TSH and haematological parameters, with 95% Confidence Intervals (CI) reported. A p-value of ≤ 0.05 was considered statistically significant.

**Results**
The study cohort included 100 participants, with a mean age distribution spanning multiple age groups. Females constituted 83% of the cohort, and the most common age group overall was 20–35 years (32%). (Table 1) shows the distribution of participants by sex across groups. (Table 2) presents the age distribution, indicating that within the 'Isolated Anaemia' group, the 20–35 years age bracket was the most common, accounting for 40% (n=14) of participants in this subgroup.

***Table 1. Distribution of Participants by Sex and Group***

| Group | Males | Females | Total |
|---|---|---|---|
| Euthyroid Non-Anaemic (Control) | 2 | 11 | 13 |
| Hypothyroidism Only | 1 | 9 | 10 |


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| | | | |
|---|---|---|---|
| Thyroid Dysfunction Only | 0 | 10 | 10 |
| Hypothyroidism with Anaemia | 4 | 18 | 22 |
| Euthyroid with Normocytic Anaemia | 3 | 7 | 10 |
| Isolated Anaemia | 7 | 28 | 35 |
| Total | 17 | 83 | 100 |

***Table 2. Distribution of Participants by Age Group***

| Group | <20 | 20-35 | 35-50 | 50-65 | 65-80 | >80 | Total |
|---|---|---|---|---|---|---|---|
| Control | 1 | 7 | 2 | 3 | 0 | 0 | 13 |
| Hypothyroidism Only | 0 | 4 | 3 | 2 | 1 | 0 | 10 |
| Thyroid Dysfunction Only | 0 | 0 | 1 | 8 | 1 | 0 | 10 |
| Hypothyroidism with Anaemia | 3 | 3 | 6 | 5 | 6 | 0 | 22 |
| Euthyroid with Normocytic Anaemia | 0 | 4 | 0 | 2 | 4 | 0 | 10 |
| Isolated Anaemia | 1 | 14 | 5 | 8 | 5 | 1 | 35 |
| Total | 5 | 32 | 17 | 28 | 17 | 1 | 100 |

***Group 1: Isolated Anaemia (n=35)***

Participants had a mean haemoglobin of 10.4 ± 1.9 g/dL and RBC of 3.55 ± 1.2 million/µL, with an elevated MCV of 103.7 ± 25.1 fL, indicating a macrocytic pattern. Mean TSH was 2.08 ± 0.9 mIU/L, within the normal reference range (Table 3).

***Table 3. Haematological and TSH Parameters in Isolated Anaemia Group***

| Parameter | TSH (mIU/L) | RBC (million/µL) | WBC (x10$^3$/µL) | HGB (g/dL) | MCV (fL) |
|---|---|---|---|---|---|
| Mean ± SD | 2.08 ± 0.9 | 3.55 ± 1.2 | 7.69 ± 4.2 | 10.4 ± 1.9 | 103.7 ± 25.1 |
| P-value (vs. Control) | 0.78 | 0.12 | 0.34 | <0.001* | <0.001* |

**Statistically significant at P ≤ 0.05*

***Group 2: Hypothyroidism Only (n=10)***

Patients presented with elevated TSH (7.73 ± 6.4 mIU/L). Haematological parameters remained within normal ranges (HGB: 13.64 ± 0.7 g/dL; MCV: 79.5 ± 28.7 fL). (Table 4).

***Table 4. Haematological and TSH Parameters in Hypothyroidism Only Group***

| Parameter | TSH (mIU/L) | RBC (million/µL) | WBC (x10$^3$/µL) | HGB (g/dL) | MCV (fL) |
|---|---|---|---|---|---|
| Mean ± SD | 7.73 ± 6.4 | 4.18 ± 1.6 | 7.01 ± 1.9 | 13.64 ± 0.7 | 79.5 ± 28.7 |
| P-value (vs. Control) | <0.001* | 0.45 | 0.52 | 0.28 | 0.31 |

**Statistically significant at P ≤ 0.05*

***Group 3: Thyroid Dysfunction Only (n=10)***

This group exhibited abnormal TSH (0.92 ± 0.98 mIU/L). CBC indices were within normal ranges (HGB: 13.24 ± 0.76 g/dL; MCV: 87.69 ± 5.94 fL) (Table 5).

***Table 5. Haematological and TSH Parameters in Thyroid Dysfunction Only Group***

| Parameter | TSH (mIU/L) | RBC (million/µL) | WBC (x10$^3$/µL) | HGB (g/dL) | MCV (fL) |
|---|---|---|---|---|---|
| Mean ± SD | 0.92 ± 0.98 | 4.48 ± 0.38 | 6.23 ± 2.46 | 13.24 ± 0.76 | 87.69 ± 5.94 |
| P-value (vs. Control) | 0.04* | 0.32 | 0.87 | 0.76 | 0.58 |

**Statistically significant at P ≤ 0.05*

***Group 4: Hypothyroidism with Anaemia (n=22)***

This group represented 22% of the total cohort. Mean TSH was significantly elevated (6.15 ± 5.47 mIU/L). Haematological analysis confirmed microcytic anaemia, with a mean HGB of 9.93 ± 1.48 g/dL and MCV of 77.47 ± 11.26 fL. Pearson's correlation analysis demonstrated a statistically significant moderate inverse relationship between TSH and HGB levels (r = -0.484, 95% CI [-0.750, -0.082], exact P = 0.022), Table (6).

***Table 6. Haematological and TSH Parameters in Hypothyroidism with Anaemia Group***

| Parameter | TSH (mIU/L) | RBC (million/µL) | WBC (x10$^3$/µL) | HGB (g/dL) | MCV (fL) |
|---|---|---|---|---|---|
| Mean ± SD | 6.15 ± 5.47 | 4.92 ± 3.98 | 6.53 ± 2.72 | 9.93 ± 1.48 | 77.47 ± 11.26 |
| P-value (vs. Control) | <0.001* | 0.23 | 0.78 | <0.001* | 0.14 |

**Statistically significant at P ≤ 0.05*


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***Group 5: Euthyroid with Normocytic Anaemia (n=10)***
Subjects exhibited normal TSH levels (1.46 ± 0.60 mIU/L), mildly reduced HGB (11.07 ± 3.18 g/dL), and normal MCV (85.74 ± 2.43 fL), indicative of a normocytic anaemia pattern in the presence of euthyroid status. (Table 7).

***Table 7. Haematological and TSH Parameters in Euthyroid with Normocytic Anaemia Group***

| Parameter | TSH (mIU/L) | RBC (million/µL) | WBC (x10$^3$/µL) | HGB (g/dL) | MCV (fL) |
|---|---|---|---|---|---|
| Mean ± SD | 1.46 ± 0.60 | 3.44 ± 0.96 | 10.28 ± 3.93 | 11.07 ± 3.18 | 85.74 ± 2.43 |
| P-value (vs. Control) | 0.42 | 0.34 | 0.12 | 0.04* | 0.72 |

**Statistically significant at P ≤ 0.05*

***Group 6: Euthyroid Non-Anaemic Control (n=13)***
The control group demonstrated a normal TSH profile (2.04 ± 0.76 mIU/L) alongside normal CBC indices (HGB: 13.14 ± 1.15 g/dL; MCV: 84.39 ± 22.45 fL) (Table 8).

***Table 8. Haematological and TSH Parameters in Control Group***

| Parameter | TSH (mIU/L) | RBC (million/µL) | WBC (x10$^3$/µL) | HGB (g/dL) | MCV (fL) |
|---|---|---|---|---|---|
| Mean ± SD | 2.04 ± 0.76 | 4.13 ± 1.22 | 6.33 ± 1.75 | 13.14 ± 1.15 | 84.39 ± 22.45 |

**Discussion**
This study evaluated the relationship between TSH levels and anaemia parameters in a cohort of patients from Misurata, Libya. The findings indicate a significant association between elevated TSH levels and reduced haemoglobin concentrations, consistent with previous reports suggesting a link between hypothyroidism and anaemia [10]. The observed inverse correlation between TSH and haemoglobin (r = -0.484) in the hypothyroidism-with-anaemia group aligns with global meta-analyses [11] and regional studies [7]. This relationship may be explained by the role of thyroid hormones in stimulating erythropoietin (EPO) release and facilitating intestinal iron absorption. The reduced haemoglobin and diminished MCV in patients with elevated TSH suggest impaired erythropoiesis, possibly due to reduced gastric acid secretion and impaired iron uptake, as previously reported by [12]. The identification of microcytic anaemia in the hypothyroidism-with-anaemia group and normocytic anaemia in the thyroid dysfunction-with-anaemia group suggests that different mechanisms may underlie anaemia in the context of thyroid dysfunction. Microcytic anaemia may reflect iron deficiency, while normocytic anaemia may represent anaemia of chronic disease. However, without measurement of iron studies (ferritin, transferrin saturation), vitamin B12, folate, and reticulocyte count, the specific etiology of anaemia cannot be definitively determined. The high proportion of females (83%) in our cohort reflects the global epidemiology of autoimmune thyroid diseases, such as Hashimoto's thyroiditis, which show a well-documented female predominance [13]. Additionally, menstruation and pregnancy predispose women to iron deficiency anaemia, increasing the likelihood of concurrent thyroid-haematological comorbidities.

**Expanded Clinical Implications:**
The strong inverse correlation observed between TSH and haemoglobin in our cohort has direct implications for clinical practice in Libya. Given the high prevalence of both thyroid disorders and nutritional anaemia in the region, our findings suggest that a simple, cost-effective TSH screening could be a valuable addition to the initial workup of unexplained anaemia, particularly in women of reproductive age. Early identification of concurrent hypothyroidism could prevent the failure of standard iron supplementation therapy, as thyroid hormone replacement is often required to restore normal erythropoietin responsiveness and iron absorption.

**Pathophysiological Context:**
The coexistence of normocytic anaemia with normal TSH levels (Group 5) highlights the multifactorial nature of anaemia in this population. While hypothyroidism directly impairs erythropoiesis, normocytic anaemia in euthyroid patients may be driven by other prevalent local factors, such as undiagnosed chronic inflammation, early-stage nutritional deficiencies, or heterozygous haemoglobinopathies, which are known to be endemic in the Mediterranean region.

***Study Limitations***
This study has several limitations. First, the sample size in several subgroups (e.g., n=10) was small, reducing statistical power and resulting in wide confidence intervals for correlation coefficients. These findings should be interpreted as preliminary and require validation in larger cohorts. Second, TSH was used as the sole thyroid marker; measurement of free T3 and free T4 would have provided a more comprehensive assessment of thyroid function. Third, the study did not include iron studies, vitamin B12, folate levels, or screening for haemoglobinopathies (including thalassemia, which is prevalent in the Mediterranean region), limiting the ability to determine the specific etiology of anaemia. Fourth, the single-centre design


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in Misurata may limit the generalizability of the results to the broader Libyan population. Finally, the cross-sectional design precludes establishment of causal relationships between thyroid dysfunction and anaemia.

## Conclusion

This study demonstrates a significant association between elevated TSH levels and reduced haemoglobin concentrations in the studied Libyan population. Patients with elevated TSH had significantly lower haemoglobin levels compared to euthyroid controls, and an inverse correlation was observed between TSH and haemoglobin in the hypothyroidism-with-anaemia group. These findings suggest that thyroid dysfunction should be considered in the differential diagnosis of anaemia, particularly in cases unresponsive to standard iron therapy.

### *Highlights*

1. This study evaluates the relationship between TSH levels and anaemia parameters in a Libyan patient cohort.
2. Twenty-two percent of patients with elevated TSH had concurrent anaemia, predominantly microcytic.
3. An inverse correlation was found between TSH and haemoglobin levels (r = -0.484, 95% CI [-0.750, -0.082]).
4. Thyroid function screening should be considered in the evaluation of unexplained anaemia.
5. Further studies with comprehensive thyroid and haematological panels are needed to validate these findings.

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