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Prevalence of Thyroid Dysfunction and Thyroid Hormone Levels Among Pregnant Women in Tripoli, Libya: A Cross-Sectional Study

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ABSTRACT

Purpose: To determine the prevalence of thyroid hormone abnormalities and describe the distribution of thyroid-stimulating hormone (TSH), total triiodothyronine (T3), and total thyroxine (T4) concentrations across pregnancy trimesters among pregnant women attending care in the Tripoli region of Libya.

Materials and Methods: This cross-sectional study enrolled 168 pregnant women aged 18–45 years between February 2025 and February 2026. Serum TSH, total T3, and total T4 were measured using an iFlash 1800 automated chemiluminescence immunoassay analyser and categorised against the laboratory's reference intervals (TSH 0.4–4.0 μIU/mL; total T3 0.8–2.0 nmol/L; total T4 57.9–150.6 nmol/L). Data were analysed using SPSS version 20, and mean hormone concentrations were compared descriptively across the three pregnancy trimesters.

Results: Participants were distributed across the first (39.9%), second (31.5%), and third (28.6%) trimesters. Abnormal results were found in 5.95% of women for TSH (3.57% above range, 2.38% below range), 3.57% for total T3, and 1.19% for total T4. Mean TSH concentrations were broadly similar across trimesters (2.03 ± 0.89, 1.90 ± 1.72, and 2.50 ± 1.77 μIU/mL in the first, second, and third trimesters, respectively), whereas total T3 (1.36 ± 0.49, 0.94 ± 0.14, and 1.18 ± 0.59 nmol/L) and total T4 (71.50 ± 19.75, 84.13 ± 25.32, and 76.16 ± 22.99 nmol/L) concentrations showed clearer trimester-to-trimester variation, with total T3 lowest and total T4 highest in the second trimester.

Conclusion: Overall thyroid hormone abnormalities were relatively uncommon in this cohort, but total T3 and total T4 concentrations varied noticeably across pregnancy trimesters. These findings support continued antenatal thyroid screening and highlight the need for larger, multicentre Libyan studies incorporating trimester-specific reference intervals. (*Open J Biomed Res 2026;5:114-122*)

Keywords: Thyroid dysfunction, Pregnancy, Thyroid-stimulating hormone, Triiodothyronine, Thyroxine.

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AUDIOABSTRACT

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INTRODUCTION

Thyroid hormones are essential regulators of maternal metabolism and fetal neurodevelopment, and pregnancy imposes profound and dynamic demands on the maternal thyroid gland. [1] Rising human chorionic gonadotropin (hCG) concentrations in early

gestation transiently stimulate the thyroid-stimulating hormone (TSH) receptor and suppress TSH, while oestrogen-driven increases in thyroxine-binding globulin (TBG) progressively raise total triiodothyronine (T3) and total thyroxine (T4) concentrations as pregnancy advances. [1,2] Because of these physiological shifts, current guidelines and laboratory-medicine reviews recommend the use of trimester- and assay-specific reference intervals, rather than standard non-pregnant ranges, when interpreting thyroid function tests in pregnancy. [3-5]

Thyroid dysfunction in pregnancy encompassing overt and subclinical hypothyroidism, hyperthyroidism, and isolated hypothyroxinaemia has been consistently associated with adverse maternal and fetal outcomes, including gestational hypertension and pre-eclampsia, [6] as well as lower offspring IQ and a higher risk of neurodevelopmental disorders. [7,8] Reported prevalence varies widely by population, iodine status, and diagnostic threshold; a systematic review has shown that the specific criteria used to define hypothyroidism and hyperthyroidism substantially influence prevalence estimates across studies. [9] In sub-Saharan Africa, a pooled prevalence of thyroid dysfunction of 12.0% has been reported among pregnant women,[10] and a recent meta-analysis of pregnant Arab women found a pooled subclinical hypothyroidism prevalence of 20%, [11] figures considerably higher than early pooled estimates derived largely from iodine-sufficient Western cohorts. Iodine status is thought to be an important determinant of this regional variability: insufficient iodine intake in pregnancy remains common worldwide[12] and across the African continent despite salt-iodisation programmes. [13]

Data from neighbouring Arab countries illustrate this regional heterogeneity. Egyptian population-based studies have derived local trimester-specific reference intervals that differ from Western values, [14,15] and hospital-based Egyptian series have reported thyroid dysfunction in a substantial proportion of screened pregnant women. [16] A regional survey of endocrinologists across the Middle East and North Africa further documented marked heterogeneity in screening thresholds and management practices for thyroid disease in pregnancy. [17] By contrast, data from Libya remain very scarce: a recent pilot study of a Libyan clinical cohort explicitly noted that Libya, despite being one of the largest countries in North Africa, lacks sufficient population-based data on the frequency of thyroid disorders, [18] and the only other Libyan series identified a retrospective study of women already diagnosed with subclinical hypothyroidism at Tripoli University Hospital described obstetric complications in this selected group rather than thyroid hormone distributions in an unselected antenatal population. [19]

Given this important gap in the Libyan literature, the present study aimed to determine the prevalence of thyroid hormone abnormalities and to describe the distribution of TSH, total T3, and total T4 concentrations across pregnancy trimesters among pregnant women attending care in the Tripoli region of Libya.

MATERIALS AND METHODS

Study Design and Participants

This cross-sectional study was conducted between February 2025 and February 2026 in private medical laboratories in the Tripoli region of Libya. The study included 168 pregnant women aged 18–45 years who attended the participating private laboratories during the study period and met the eligibility criteria. Participation was based on the availability of eligible participants and their willingness to participate; Therefore, a convenience sampling approach was used. The study did not include all pregnant women attending antenatal services in the Tripoli region, and the sample was limited to eligible women who presented to the participating private laboratories and agreed to participate. Women with a previously

diagnosed thyroid disorder before the current pregnancy were excluded. Maternal age and gestational trimester were recorded at enrolment, and participants were classified into first, second, and third-trimester groups according to gestational age.

Blood Sampling and Laboratory Analysis

Approximately 5 mL of venous blood was collected from each participant using standard phlebotomy procedures. The blood samples were processed to obtain serum by centrifugation and were subsequently analyzed for thyroid stimulating hormone (TSH), total triiodothyronine (total T3), and total thyroxine (total T4) using an iFlash 1800 automated chemiluminescence immunoassay analyzer, according to the established procedures of the participating laboratories. For classification of thyroid function results, the general, non-pregnancy specific reference intervals used by the participating laboratories were applied: 0.4 – 4.0 µIU/mL for TSH, 0.8–2.0 nmol/L for total T3, and 57.9 – 150.6 nmol/L for total T4. These intervals were the reference values actually used for classification in the present study and were not considered trimester-specific pregnancy reference intervals.

Study Outcomes

The primary outcome was the prevalence of thyroid hormone abnormalities among the study participants based on the reference intervals used by the participating laboratories. Secondary outcomes included the mean concentrations of TSH, total T3, and total T4 according to pregnancy trimester and the distribution of results classified as above or below the applicable reference interval.

Data Analysis

Data were entered and analyzed using SPSS version 20. Continuous variables were summarised as means and standard deviations (SD), while categorical variables were presented as frequencies and percentages. Mean hormone concentrations and the distribution of abnormal results were compared descriptively across the three pregnancy trimesters. No inferential statistical tests were performed.

Ethical Considerations

Before enrollment, the purpose and procedures of the study were explained to the participants, and verbal informed consent was obtained from each participant. To protect confidentiality, study participants were assigned codes, and no names or other directly identifying personal information were collected or used in the study database or analysis.

RESULTS

The results showed that the majority of participants (52.4%) were aged between 30 and 39 years, followed by women aged 20–29 years (28.6%). Only a small proportion of participants were younger than 20 years (1.2%) or older than 40 years (17.9%) (Fig 1). This distribution indicates that most pregnancies in this cohort occurred within the third and fourth decades of life, consistent with the typical childbearing age range in the local population.

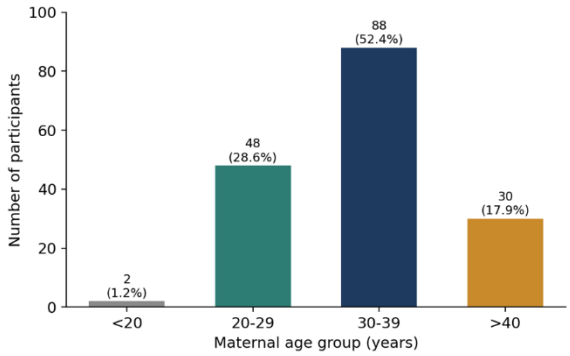


Fig 1: Age distribution of the study participants (N = 168).

The study participants were recruited across all three trimesters of pregnancy, with the largest proportion sampled in the first trimester (39.9%), followed by the second (31.5%) and third trimesters (28.6%) (Fig 2). This distribution provided a reasonably balanced representation of thyroid function across the course of pregnancy and allowed meaningful comparison of hormone concentrations between the three gestational stages.

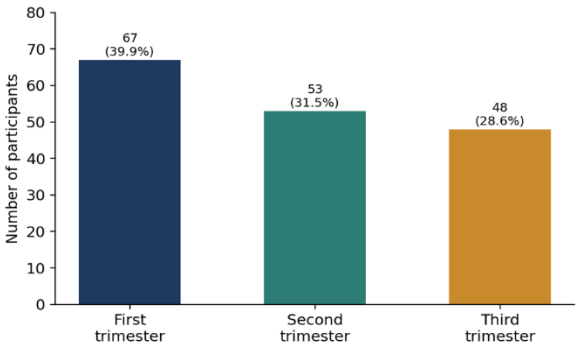


Fig 2: Distribution of participants by pregnancy trimester (N = 168).

The mean concentrations of TSH, total T3, and total T4 across the three trimesters are summarized in Table 1. The results showed the mean TSH concentration was lowest in the second trimester (1.90 ± 1.716 μIU/mL) and highest in the third trimester (2.50 ± 1.766 μIU/mL), remaining on average within the laboratory reference interval throughout pregnancy. Mean total T3 concentration was highest in the first trimester (1.36 ± 0.491 nmol/L) and lowest in the second trimester (0.94 ± 0.138 nmol/L), while mean total T4 concentration followed the opposite pattern, peaking in the second trimester (84.13 ± 25.316 nmol/L) and declining somewhat in the third trimester (76.16 ± 22.985 nmol/L). Across all trimesters combined, the pooled mean concentrations (TSH 2.12 ± 1.473 μIU/mL; total T3 1.18 ± 0.479 nmol/L; total T4 76.82 ± 23.040 nmol/L) remained within the normal laboratory range, reflecting the generally euthyroid status of most participants across gestation.

Table 2 presents the percentage of women with TSH concentrations falling within, exceeding, or below the laboratory reference range in each trimester. Overall, the vast majority of participants (94.05%) had TSH values within the laboratory reference range across the three trimesters. Mildly elevated TSH concentrations were more frequently observed in the first trimester (7.5%), whereas low TSH concentrations were more frequent in the second trimester (5.7%). No abnormal TSH values were observed during the third trimester, with all recorded TSH concentrations falling within the laboratory reference range. These findings indicate that, in this cohort, TSH concentrations were predominantly within the laboratory reference range throughout pregnancy, with relatively few abnormal values observed in the first and second trimesters.

Table 1: TSH, total T3, and total T4 concentrations by pregnancy trimester.

Trimester	n	TSH (μIU/mL) Mean ± SD	Total T3 (nmol/L) Mean ± SD	Total T4 (nmol/L) Mean ± SD
First trimester	67	2.03 ± 0.894	1.36 ± 0.491	71.50 ± 19.749
Second trimester	53	1.90 ± 1.716	0.94 ± 0.138	84.13 ± 25.316
Third trimester	48	2.50 ± 1.766	1.18 ± 0.586	76.16 ± 22.985
Total	**168**	**2.12 ± 1.473**	**1.18 ± 0.479**	**76.82 ± 23.040**

Table 2: Distribution of TSH results relative to the laboratory reference interval (0.4–4.0 μIU/mL), by pregnancy trimester.

Trimester	Within range n (%)	Above range n (%)	Below range n (%)	Total
First trimester	61 (91.0)	5 (7.5)	1 (1.5)	67
Second trimester	49 (92.5)	1 (1.9)	3 (5.7)	53
Third trimester	48 (100.0)	0 (0.0)	0 (0.0)	48
All trimesters	**158 (94.05)**	**6 (3.57)**	**4 (2.38)**	**168**

Table 3: Distribution of total T3 results relative to the laboratory reference interval (0.8–2.0 nmol/L), by pregnancy trimester.

Trimester	Within range n (%)	Above range n (%)	Below range n (%)	Total
First trimester	65 (97.0)	0 (0.0)	2 (3.0)	67
Second trimester	51 (96.2)	0 (0.0)	2 (3.8)	53
Third trimester	46 (95.8)	1 (2.1)	1 (2.1)	48
All trimesters	**162 (96.43)**	**1 (0.60)**	**5 (2.98)**	**168**

As presented in Table 3, serum total T3 concentrations were within the reference range in the large majority of women (96.43% overall). Low T3 values were slightly more common than elevated values across all trimesters, occurring in the first, second, and third trimesters alike, while a single case of elevated T3 was identified in the third trimester. Together, these results account for the modest overall prevalence of abnormal total T3 concentrations (3.57%) observed in this cohort.

Table 4 shows that total T4 concentrations were within the laboratory reference range in nearly all study participants (98.81% overall), with no elevated total T4 values recorded in any trimester. The few below-range values observed occurred exclusively in the first and third trimesters, with none recorded in the second trimester, a pattern that corresponds to the higher mean T4 concentration noted in the second trimester in Table 1.

Table 4: Distribution of total T4 results relative to the laboratory reference interval (57.9–150.6 nmol/L), by pregnancy trimester.

Trimester	Within range n (%)	Above range n (%)	Below range n (%)	Total
First trimester	66 (98.5)	0 (0.0)	1 (1.5)	67
Second trimester	53 (100.0)	0 (0.0)	0 (0.0)	53
Third trimester	47 (97.9)	0 (0.0)	1 (2.1)	48
All trimesters	**166 (98.81)**	**0 (0.0)**	**2 (1.19)**	**168**

DISCUSSION

To our knowledge, this study is among the few studies to describe the distribution of TSH, total T3, and total T4 across pregnancy trimesters among pregnant women attending private medical laboratories in Tripoli, Libya. Previous Libyan studies have examined thyroid function or thyroid-related pregnancy outcomes in specific clinical populations. For example, a study from Benghazi reported thyroid function findings among women screened during the third trimester of pregnancy,[20] while another study evaluated subclinical hypothyroidism and adverse pregnancy outcomes among women with an established diagnosis of subclinical hypothyroidism.[19] In addition, a recent Libyan pilot study of thyroid disorders highlighted the limited availability of population-level data on thyroid disease in Libya.[18] The present study therefore adds to the existing Libyan evidence by describing TSH, total T3, and total T4 concentrations and the distribution of abnormal results across the three pregnancy trimesters in a sample of pregnant women attending private laboratories in Tripoli.

The overall prevalence of abnormal thyroid hormone results observed in this cohort 5.95% for TSH, 3.57% for total T3, and 1.19% for total T4 is considerably lower than pooled estimates reported elsewhere in the region and on the

continent. A meta-analysis of pregnant Arab women reported a pooled subclinical hypothyroidism prevalence of 20%,[11] and a systematic review from the Horn of Africa reported an overall thyroid dysfunction prevalence of 12.0%.[10] Hospital-based Egyptian series have similarly reported thyroid dysfunction in a substantial minority of screened pregnant women,[14-16] and a regional survey of endocrinologists across the Middle East and North Africa has documented wide variation in screening thresholds and management practices for thyroid disease in pregnancy.[17] Together with differences, in population iodine status and study design, this variability in diagnostic thresholds shown elsewhere to substantially influence reported prevalence estimates may partly explain the comparatively low abnormality rate observed in the present study sample.[9]

It is important to distinguish between the general, non-pregnancy specific laboratory reference intervals used for classification in this study and pregnancy-specific reference intervals derived directly from pregnant populations elsewhere. The intervals applied here (TSH 0.4–4.0 μIU/mL; total T3 0.8–2.0 nmol/L; total T4 57.9–150.6 nmol/L) originate from the laboratory's standard, all-comer adult reference population and were applied uniformly across all three trimesters. Such general, all-comer reference intervals are known to perform poorly even outside pregnancy: a large paediatric-to-adulthood reference study, for example, demonstrated that thyroid hormone concentrations change markedly across the life course and that a single reference interval cannot be applied universally to all ages,[22] an argument that applies with equal force to pregnancy as a distinct physiological state. By contrast, several studies conducted directly in pregnant populations have derived trimester-specific reference intervals that differ, sometimes substantially, from general laboratory ranges. In Basrah, Iraq, trimester-specific TSH reference intervals using electro-chemiluminescent immunoassay were 0.04–3.77, 0.30–3.21, and 0.60–4.50 μIU/mL for the first, second, and third trimesters, respectively, with correspondingly shifted total T3 and total T4 ranges.[23] In Eastern Libya, a third-trimester screening study in Benghazi reported a mean TSH of 3.33 ± 1.34 μIU/mL with a 5th–95th percentile range of 0.88–5.52 μIU/mL — an upper bound above the general 4.0 μIU/mL cut-off used in the present study — together with a mean total T4 of 106.9 ± 38.2 nmol/L and mean total T3 of 1.8 ± 0.7 nmol/L.[20] Gestational-age-specific reference intervals have similarly been established in a multi-ethnic population in Singapore,[24] and a hospital-based survey of the healthy gestational population in Kinshasa, Democratic Republic of the Congo, likewise reported trimester-specific thyroid hormone distributions distinct from standard non-pregnant ranges,[25] reinforcing that population- and trimester-specific reference intervals are needed across diverse settings and not only in high-resource countries. Table 5 summarizes these pregnancy-specific reference intervals alongside the general laboratory reference intervals used in the present study.

Table 5: Comparison of the general laboratory reference intervals used in this study with pregnancy-specific reference intervals reported in other populations.

Source (population)	Trimester	TSH (μIU/mL)	Total T3 (nmol/L)	Total T4 (nmol/L)
our study- general laboratory reference (Tripoli, Libya)	All trimesters (applied uniformly)	0.4–4.0	0.8–2.0	57.9–150.6
Almomin et al. Basrah, Iraq[23]	First	0.04–3.77	1.38–3.86*	94.1–193.1*
	Second	0.30–3.21	3.06–4.41*	114.8–223.7*
	Third	0.60–4.50	1.84–4.15*	102.7–227.8*
Younis et al. Benghazi, Libya[20]	Third (mean ± SD; 5th–95th percentile)	3.33 ± 1.34 (0.88–5.52)	1.8 ± 0.7 (1.02–3.2)	106.9 ± 38.2 (61.6–181.2)

**Converted from the original reporting units (ng/mL for total T3 and μg/dL for total T4) to nmol/L using standard conversion factors (×1.536 for T3; ×12.87 for T4) to allow direct comparison with the present study.*

As shown in Table 5, applying the general laboratory TSH upper limit of 4.0 μIU/mL used in this study would misclassify a proportion of otherwise healthy Libyan women in the third trimester as biochemically hyperthyroid, based on the third-trimester upper bound of 5.52 μIU/mL reported in Benghazi;[20] conversely, the general lower TSH limit of 0.4 μIU/mL used here is lower than the first-trimester lower bound reported in Basrah,[23] which could mask mild first-trimester TSH suppression in some individuals. Total T4 concentrations in these pregnancy-specific studies were also generally higher than the general laboratory upper limit used in this study, particularly in the second trimester, suggesting that the true prevalence of elevated total T4 in this cohort may be under-detected when only the non-pregnancy-specific range is applied. These comparisons underscore that the abnormality rates reported in Tables 2–4 should be interpreted as estimates based on general, non-pregnancy-specific cut-offs rather than as definitive pregnancy specific diagnoses, and they reinforce the rationale for developing locally derived, trimester specific reference intervals for Libya.

Trimester-specific analysis showed relatively stable mean TSH concentrations across the three trimesters (2.03 ± 0.89, 1.90 ± 1.72, and 2.50 ± 1.77 μIU/mL in the first, second, and third trimesters, respectively), with a modest numerical rise in the third trimester that is broadly consistent with the expected physiological pattern of transient first-trimester TSH suppression by hCG followed by a gradual return toward, or modest rise above, non-pregnant values later in gestation.[1,2] In contrast, both total T3 and total T4 concentrations showed clearer trimester-to-trimester variation, with total T3 lowest and total T4 highest in the second trimester. Because oestrogen-driven increases in TBG progressively raise total T4 and T3 concentrations as pregnancy advances, typically peaking around mid-gestation,[1,2] the mid-pregnancy T4 peak observed here is broadly consistent with expected physiology, whereas the mid-pregnancy dip in total T3 is less readily explained and may reflect sampling variability, the relatively small second- and third-trimester subgroup sizes, or population- and assay-specific factors. Ethnic and population differences in thyroid parameters during pregnancy have been documented previously and underscore the need for locally derived reference intervals rather than reliance on values developed in other populations.[5,21]

Because thyroid status in this study was classified against the laboratory's standard, non-pregnancy specific reference intervals rather than trimester-specific ranges, as current guidelines recommend,[3,4] some women with mild trimester-specific abnormalities may have been misclassified as euthyroid, and conversely; this represents an important target for future Libyan studies incorporating locally derived, trimester-specific reference intervals such as those illustrated in Table 5. Iodine status, which was not assessed in this study, is a further plausible contributor to thyroid function patterns in this population: insufficient iodine intake in pregnancy remains common worldwide[12] and across Africa despite salt-iodisation programmes,[13] and future Libyan studies would benefit from incorporating urinary iodine measurement alongside thyroid function testing.

This study has several limitations. First, its cross-sectional, single-centre design in the Tripoli region limits generalisability to other regions of Libya and precludes causal inference. Second, total rather than free T3 and T4 were measured, and total hormone concentrations are influenced by pregnancy-related changes in TBG, which may have contributed to some of the trimester-specific patterns observed. Third, thyroid status was classified using the laboratory's standard reference intervals rather than trimester- and assay-specific pregnancy ranges, which may have led to some misclassification, as discussed above. Fourth, thyroid peroxidase antibody status, urinary iodine concentration, and maternal and neonatal outcomes were not assessed, limiting the ability to explore the

autoimmune and nutritional determinants of thyroid dysfunction or its clinical consequences in this population. Finally, the relatively modest sample size, particularly within the third-trimester subgroup, limits the precision of some subgroup estimates.

CONCLUSION

In this cross-sectional study of 168 pregnant women in Tripoli, Libya, the overall prevalence of thyroid hormone abnormalities was relatively low, but total T3 and total T4 concentrations varied noticeably across pregnancy trimesters. These findings support the continued value of thyroid function testing during antenatal care and highlight the need for larger, multicenter Libyan studies incorporating trimester-specific reference intervals, thyroid antibody status, iodine status, and pregnancy outcomes to better characterize thyroid dysfunction in this population and to inform locally appropriate screening policies.

AUTHOR CONTRIBUTIONS

Abeer Al-Muntasir: Writing – original draft, literature review, investigation, data curation, and manuscript preparation. **Mohamed Alnaied:** Conceptualization, methodology, supervision, validation, critical review, writing – review & editing, and final approval of the manuscript.

CONFLICT OF INTEREST

The authors declare no conflicts of interest concerning the research, authorship, and publication of this article.

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