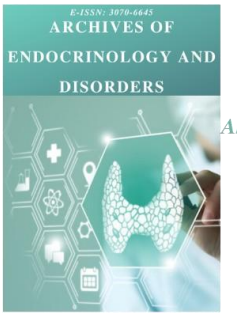

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Research Article

Assessment of Thyroid-Stimulating Hormone (TSH) Reports: Insights into Population-Level Thyroid Health

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Abstract

Background: Thyroid-Stimulating Hormone (TSH) is a sensitive biomarker of thyroid function and plays a critical role in regulating metabolism, growth, reproduction and overall endocrine health. Abnormal TSH levels are associated with thyroid disorders that can lead to significant health complications if left untreated.

Objective: To evaluate serum TSH levels among patients undergoing routine thyroid function testing and assess the prevalence of thyroid abnormalities within the study population.

Methods: A retrospective analysis was conducted on 41 patient TSH reports obtained through routine laboratory testing. Blood samples were collected in gel tube vacutainers, transported under controlled conditions and processed following standard laboratory protocols. Serum TSH levels were measured using the Chemiluminescent Enzyme Immunoassay (CLEIA) method on the COBAS e411 analyzer. Descriptive statistical parameters, including mean, median, standard deviation, range and quartiles, were calculated.

Results: TSH values ranged from 0.085 to >100.000 μIU/mL. The mean TSH level was 7.88 μIU/mL, while the median was 4.14 μIU/mL. Elevated TSH levels suggestive of hypothyroidism were observed in 20 patients (48.8%), whereas one patient (2.4%) exhibited a suppressed TSH level indicative of possible hyperthyroidism. Normal TSH values were recorded in 20 patients (48.8%). The standard deviation of 16.20 μIU/mL and range of 99.92 μIU/mL indicated substantial variability in thyroid function across the study population.

Conclusion: Nearly half of the participants demonstrated elevated TSH levels, indicating a considerable prevalence of thyroid dysfunction. Routine TSH screening and monitoring are essential for early detection and management of thyroid disorders. Larger studies incorporating free T3 and free T4 measurements are recommended to improve diagnostic accuracy and support population-specific reference ranges.

Keywords: Thyroid-Stimulating Hormone (TSH); Thyroid Function; Hypothyroidism; Hyperthyroidism; Chemiluminescent Enzyme Immunoassay (CLEIA); Thyroid Screening

Introduction

Background of the Study

Thyroid-Stimulating Hormone (TSH) is a glycoprotein hormone produced by the anterior pituitary gland. Its main function is to stimulate the thyroid gland to produce thyroid hormones. TSH also promotes the growth of thyroid follicular cells, which can lead to an enlarged thyroid. The release of TSH is controlled by the hypothalamic-pituitary axis. In this system, the hypothalamus releases Thyroid-Releasing Hormone (TRH), which acts on the anterior pituitary. TRH stimulates the thyrotroph cells of the anterior pituitary to secrete TSH. TSH then acts on the thyroid gland to release thyroid hormones, mainly Triiodothyronine (T3) and Thyroxine (T4). T3 is the active form of the thyroid hormone. Although only about 20% of T3 is directly released by the thyroid, most of it is formed from the conversion of T4 in body tissues. T4 or tetraiodothyronine, makes up more than 80% of the thyroid hormones released. Once in the bloodstream, T4 is converted into T3 by a process called de-iodination. Both T3 and T4 provide negative feedback to the anterior pituitary. High levels of these hormones decrease TSH secretion, while low levels increase TSH release [1]. Thyroid Stimulating Hormone (TSH) plays a vital role in human development. It is primarily responsible for regulating the body's metabolism. TSH is also critical for the proper functioning of the nervous system, skeletal system and reproductive tissues. Additionally, it helps regulate body temperature, heart rate, body weight and cholesterol levels. If a TSH-related disease is not treated, it can lead to more severe health issues. These may include elevated cholesterol levels, infertility and an increased risk of developing low bone density. Other potential complications are muscle weakness, osteoporosis, lupus and various autoimmune diseases. Therefore, it is important to regularly test and monitor TSH levels in patients with TSH-related conditions. Maintaining TSH within the normal range of 0.5 to 5.0 μIU/mL is essential for overall health [2-9]. Current guidelines in laboratory medicine recommend that each clinical analysis laboratory establish its own reference intervals. These intervals should be based on the specific characteristics of the local population. One way to determine reference limits is through the direct method, which involves collecting data from strictly healthy individuals. To accurately define a reference interval for an analyte, a minimum of 120 reference individuals is required. This sample size is expected to represent approximately 95% of the values found in the target population.

Objective of the Study

However, applying the direct method in routine laboratory practice can be challenging. As a result, an alternative approach known as the indirect method is often used. This method involves analyzing a large group of individuals presumed to be healthy. It operates on the assumption that more than 80% of the samples stored in laboratory information systems are from individuals without thyroid disease. These samples must also meet certain pre-selected criteria to be included in the analysis (Women-specific reference ranges for serum TSH in Liguria: the impact of age and year of collection in a single-center cross-sectional study Massimo, Thyroid-Stimulating Hormone (TSH) is a 28-kDa glycoprotein released by thyrotrophs located in the anteromedial region of the pituitary gland. It stimulates the thyroid gland to produce Thyroxine (T4) and Triiodothyronine (T3) [3]. There is a strong inverse log-linear relationship between serum TSH and serum-free T4 levels. This means that small changes in free T4 levels cause large changes in TSH levels. Because of this relationship, TSH measurement is considered superior for diagnosing thyroid disorders. Serum TSH levels are the most reliable indicator of thyroid function and are commonly used to assess thyroid status. However, certain conditions can cause TSH test results to be inaccurate due to problems with the testing method. Since clinicians often rely on TSH to detect thyroid disease, it's important to understand the situations where TSH levels may not reflect the actual thyroid condition. One such situation is pregnancy. Pregnant women, especially in the first trimester, have different thyroid function patterns. Therefore, pregnancy-specific reference ranges are necessary. Also, during pregnancy, thyroid and pituitary functions are not stable.

Specific Aim and Hypothesis

As a result, TSH levels alone may not be enough to accurately assess thyroid function. This article discusses both the laboratory and clinical aspects of measuring serum TSH and its role in detecting subtle thyroid problems in pregnancy. Since a single TSH test can provide useful information about thyroid status, it is recommended that all pregnant women have their TSH levels tested as soon as pregnancy is confirmed [4,8].

Methodology

Sample Collection

Blood samples were collected from patients using gel tube vacutainers under standard laboratory procedures. Immediately after collection, the samples were transported to the laboratory using gel packs to maintain sample integrity and preserve analyte

stability during transit. Upon arrival at the laboratory, all samples underwent accessioning, where patient demographic and personal details were verified and recorded in the laboratory information system. Each sample was then assigned a unique identification number through barcode generation to ensure accurate sample tracking and minimize pre-analytical errors [5].

Serum Separation and Analysis

Following registration, the blood samples were subjected to serum separation by centrifugation to obtain clear serum for biochemical analysis [6]. The separated serum samples were analyzed for Thyroid-Stimulating Hormone (TSH) levels using the Chemiluminescent Enzyme Immunoassay (CLEIA) method. The analysis was performed on the COBAS e411 analyzer, following the manufacturer's operating procedures and quality control guidelines. After completion of testing, the analytical results were automatically transferred and integrated into the Laboratory Information Management System (LIMS) for report generation, verification and final result documentation [7,10].

Interpretation of Results

Female Participants (n = 119)

Out of 119 female participants, 94 (78.99) demonstrated normal TSH levels, showing that the majority were euthyroid (normal thyroid function). Elevated TSH concentrations were found in 24 (20.17 females, pointing toward potential hypothyroidism, whereas a single participant (0.84) presented with suppressed TSH, which can signal hyperthyroidism. The group recorded a mean TSH value of 4.02 μIU/mL compared to a median of 2.18 μIU/mL, reflecting a right-skewed pattern driven by a handful of subjects with exceptionally high TSH readings. Overall, these results indicate that hypothyroidism represents the primary thyroid imbalance among females in this cohort.

Male Participants (n = 32)

For the 32 male participants, 20 (62.5) presented with normal TSH levels, making euthyroidism the most frequent thyroid state. Nevertheless, 10 (31.25) males exhibited raised TSH levels, showing a higher rate of hypothyroidism than observed in females. Furthermore, 2 (6.25) male subjects had low TSH levels, pointing to probable hyperthyroidism. The mean TSH for males was 7.53 μIU/mL against a median of 2.45 μIU/mL, highlighting a strong positive skew caused by a few individuals with very elevated TSH values. Despite the smaller male sample, these outcomes indicate a higher overall proportion of thyroid dysfunction—particularly hypothyroidism—within this subgroup.

Overall Cohort Breakdown (n = 151) (Table 1-3)

TSH Category	Female n (%)	Male n (%)	Total Cohort N (%)
Low (<0.5 μIU/mL)	1 (0.84%)	2 (6.25%)	3 (2.0%)
Normal (0.5 – 5.0 μIU/mL)	94 (78.99%)	20 (62.50%)	114 (75.5%)
High (>5.0 μIU/mL)	24 (20.17%)	10 (31.25%)	34 (22.5%)
Total	**119 (100.0%)**	**32 (100.0%)**	**151 (100.0%)**

Table 1: TSH category distribution.

Sex	Normal	High	Low	Total
Female	94	24	1	119
Male	20	10	2	32
Total	**114**	**34**	**3**	**151**

Table 2: Thyroid function by sex.

Finding	Interpretation
Predominant status	Normal thyroid function predominated (75.5%)
Main abnormality	Elevated TSH / Hypothyroidism (22.5%)
Distribution	Right-skewed due to high TSH outliers
Recommendation	Evaluate abnormal TSH with FT3, FT4 and thyroid antibodies

Table 3: Study findings and interpretation.

In total, the study evaluated 151 participants, consisting of 119 females (78.8) and 32 males (21.2). Normal thyroid status was confirmed in 114 subjects (75.5), establishing that euthyroidism was predominant across the combined group. Elevated TSH levels occurred in 34 individuals (22.5), confirming hypothyroidism as the most frequent thyroid disorder, while low TSH levels were identified in just 3 participants (2.0), suggesting hyperthyroidism.

Comparative analysis by sex revealed a higher percentage of elevated TSH in males (31.25) than in females (20.17), whereas females exhibited a higher rate of normal thyroid function (78.99 vs. 62.5) shown in Tab 3. Both cohorts displayed positively skewed TSH distributions-evidenced by mean values notably higher than medians demonstrating the impact of a few outlier cases with marked TSH elevations. The scattered plots reveals the distribution of TSH hormone in male and female participants of elevation and reduction rates (Fig. 1-3).

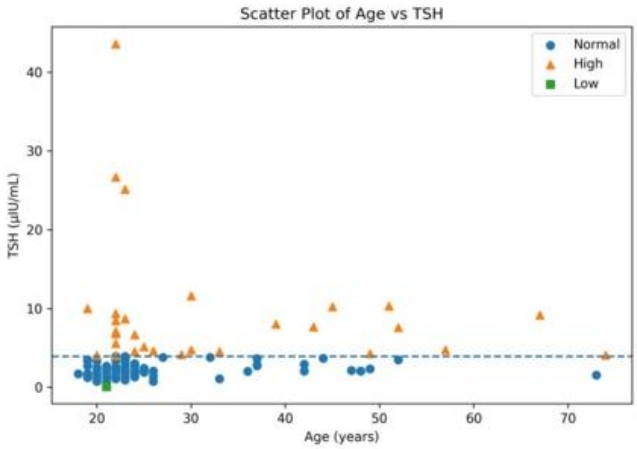

Figure 1: TSH Concentrations of female participants.

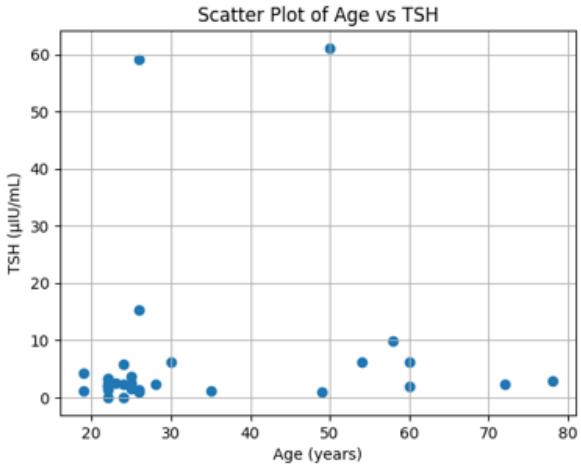

Figure 2: TSH Concentrations of male participants.

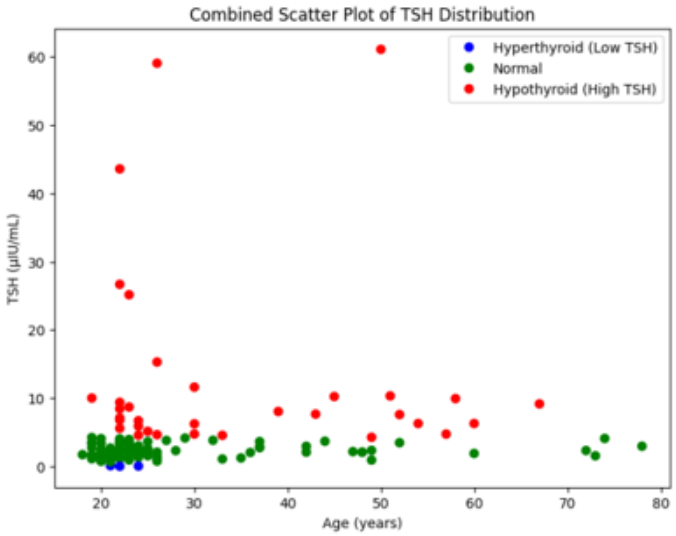

Figure 3: TSH concentrations of both male and female participants comparison.

The scatter plot demonstrates the distribution of TSH levels according to age and thyroid function status. Most participants exhibited normal thyroid function, with TSH values clustered within the reference range across all age groups. Elevated TSH values indicative of hypothyroidism were more frequent than suppressed TSH values associated with hyperthyroidism.

Although a few individuals demonstrated markedly elevated TSH concentrations, no clear age-related trend in TSH levels was observed. The presence of several extreme values resulted in a right-skewed distribution, suggesting that hypothyroidism contributed substantially to the variability in TSH concentrations within the study population.

Conclusion

Nearly half of the participants demonstrated elevated TSH levels, indicating a considerable prevalence of thyroid dysfunction. Routine TSH screening and monitoring are essential for early detection and management of thyroid disorders. Larger studies incorporating free T3 and free T4 measurements are recommended to improve diagnostic accuracy and support population-specific reference ranges.

Conflict of Interest

The authors declared no potential conflicts of interest with respect to the research, authorship and/or publication of this article.

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Data Availability Statement

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

Ethical Statement

The project did not meet the definition of human subject research under the preview of the IRB according to federal regulations and therefore was exempt.

Informed Consent Statement

Informed consent was obtained from all participants included in the study.

Authors' Contributions

All authors contributed equally to this paper.

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