

Relationship between thyroid function tests and cytological patterns of thyroid nodules: a hospital-based cross-sectional observational study.

Dr. Sailusha Sreerama¹, Dr. Nadera Sultana², Dr. Rama Shouri³

Page | 1

¹Assistant Professor, Department of Biochemistry, Government Medical College, Vikarabad, Telangana, India

²Assistant Professor, Department of Pathology, Government Medical College, Vikarabad, Telangana, India

³Professor and Head, Department of Biochemistry, Government Medical College, Vikarabad, Telangana, India

Abstract

Background

Thyroid nodules are frequently encountered in clinical practice. Although most are benign, fine-needle aspiration cytology is essential for risk classification. Serum thyroid-stimulating hormone has also been investigated as a supplementary marker of cytological and malignant potential.

Objectives

To describe thyroid function and cytological patterns among patients with thyroid nodules and assess the relationship between thyroid function tests and Bethesda cytological categories

Methods

This hospital-based cross-sectional observational study included 80 patients with clinically or radiologically detected thyroid nodules at Government Medical College and Hospital, Vikarabad, Telangana, India, from October 2024 to September 2025. Serum thyroid-stimulating hormone, free thyroxine and free triiodothyronine were measured. Fine-needle aspiration cytology was classified using the Bethesda system. Associations were evaluated using appropriate categorical and non-parametric tests.

Results

The mean age was 44.8 ± 13.2 years, and 62 participants (77.5%) were female. Fifty patients (62.5%) were euthyroid, 21 (26.3%) had hypothyroid patterns and nine (11.3%) had hyperthyroid patterns. Bethesda category II was observed in 52 nodules (65.0%); six nodules (7.5%) had malignant cytology and four (5.0%) were suspicious for malignancy. Median thyroid-stimulating hormone increased from 2.3 mIU/L in benign cytology to 4.1 mIU/L in Bethesda categories III–V and 4.8 mIU/L in malignant cytology. Elevated thyroid-stimulating hormone was associated with non-benign cytology (odds ratio 4.04; 95% confidence interval 1.38–11.87). Free thyroid hormone concentrations were not significantly associated with cytological risk.

Conclusion

Benign nodules and euthyroid status predominated. Higher serum thyroid-stimulating hormone concentrations were associated with increasing cytological risk, supporting their use as an adjunct rather than a substitute for ultrasonography and cytology.

Recommendations

Serum thyroid-stimulating hormone should be interpreted alongside clinical examination, ultrasound risk features and Bethesda category when prioritising evaluation and follow-up of thyroid nodules.

Keywords: Bethesda system; fine-needle aspiration cytology; thyroid nodule; thyroid-stimulating hormone; thyroid function tests

Submitted:: April 19, 2026 **Accepted:** May 21, 2026 **Published:** June 30, 2026

Corresponding Author: Dr. Nadera Sultana

Email id: [syedanadera@yahoo.co.in](mailto:syednadera@yahoo.co.in)

Assistant Professor Department of Pathology, Government Medical College, Vikarabad, Telangana, India

Introduction

Thyroid nodules are discrete lesions within the thyroid gland that are radiologically distinguishable from the surrounding parenchyma. Their reported prevalence varies according to the population and the detection method, ranging from a small proportion on palpation to substantially higher rates with high-resolution ultrasonography. Nodules are encountered more frequently in women and older adults, and their detection has increased with the widespread use of neck imaging for unrelated indications.¹ Most nodules are benign and clinically indolent; nevertheless, the central diagnostic concern is to identify the smaller subgroup requiring

cytological assessment, surveillance or definitive treatment.²

The contemporary evaluation of a thyroid nodule combines history, physical examination, serum thyroid-stimulating hormone (TSH) measurement and ultrasonography. TSH is recommended as the initial biochemical test because a suppressed concentration can indicate an autonomously functioning lesion, whereas a normal or elevated concentration generally directs assessment toward ultrasound-based risk stratification and fine-needle aspiration cytology (FNAC).³ Ultrasound establishes the number, size, composition, echogenicity, margins, shape and echogenic foci of nodules and guides decisions regarding aspiration.⁴ Standardised systems such as the American College of Radiology Thyroid Imaging Reporting and Data System improve consistency in ultrasound reporting and biopsy selection.⁵

FNAC remains the principal minimally invasive procedure for categorising thyroid nodules before surgery. The Bethesda System for Reporting Thyroid Cytopathology classifies aspirates into six diagnostic categories, ranging from non-diagnostic material to malignant cytology, with each category linked to an expected risk range and a management pathway.⁶ The system reduces ambiguous terminology, supports communication between clinicians and pathologists and facilitates comparison across institutions. Meta-analytic evidence has demonstrated high overall diagnostic performance, particularly a strong negative predictive value for benign cytology, although indeterminate categories continue to create diagnostic and management challenges.⁷

Beyond its established role in determining functional status, serum TSH has been explored as a marker associated with thyroid neoplasia. Several studies have reported progressively greater risks of differentiated thyroid carcinoma with increasing TSH concentrations, including values within the reference interval.^{8,9} Similar relationships have been described among patients presenting with thyroid nodules and in prospective cohorts undergoing cytological or surgical evaluation.^{10,11} Some investigators have additionally reported associations between lower free thyroid hormone concentrations and malignancy,¹² while demographic features such as male sex and solitary nodularity have also been linked with cytological cancer risk.¹³ However, these findings vary across populations, laboratory methods, selection criteria and outcome definitions. Local data integrating thyroid function with cytological categories remain limited.

The present study was undertaken to characterise the demographic, clinical, biochemical and cytological profile of patients with thyroid nodules attending a tertiary-care hospital. The primary objective was to determine the relationship between serum TSH concentration and Bethesda cytological patterns. Secondary objectives were to describe the distribution of thyroid dysfunction, compare free triiodothyronine and free thyroxine concentrations across cytological risk groups, and examine whether age, sex, nodule size or solitary nodularity were associated with non-benign cytology.

Materials and methods

Study design and setting

A hospital-based cross-sectional observational study was conducted at Government Medical College and Hospital, Vikarabad, Telangana, India, from October 2024 to September 2025. Reporting followed the Strengthening the Reporting of Observational Studies in Epidemiology recommendations.¹⁴ The institution is a tertiary-care teaching hospital that provides outpatient and inpatient clinical services to patients from Vikarabad and the surrounding areas. Patients with thyroid swellings or thyroid nodules are evaluated through relevant clinical departments and, when indicated, undergo laboratory investigations, ultrasonography and fine-needle aspiration cytology (FNAC). The hospital has access to Biochemistry, Pathology, Radiodiagnosis and General Medicine services, which facilitated multidisciplinary evaluation of patients included in the present study. Serum thyroid-stimulating

hormone (TSH), free thyroxine (fT4) and free triiodothyronine (fT3) measurements were performed through laboratory services, while thyroid nodules were assessed radiologically and FNAC specimens were evaluated by the Department of Pathology using the Bethesda System for Reporting Thyroid Cytopathology. Thus, the study setting permitted integrated clinical, biochemical, radiological and cytological assessment of patients presenting with thyroid nodules.

Study population and sampling

Patients aged 18 years or older with a clinically palpable or radiologically detected thyroid nodule were screened. Consecutive eligible patients were enrolled until 80 participants were included. Availability of serum TSH, free thyroxine (fT4), free triiodothyronine (fT3) and thyroid FNAC findings was required. Previous thyroid surgery, long-term thyroid-specific treatment affecting biochemical status, incomplete thyroid function results, refusal of FNAC and inadequate consent were exclusion criteria. For multinodular glands, the dominant or sonographically most relevant nodule was analysed.

Clinical and ultrasonographic assessment

A structured form recorded age, sex, symptoms, compressive complaints and treatment history. Neck examination classified lesions as solitary nodules or dominant nodules within multinodular glands. Ultrasonography documented maximum diameter and supported aspiration decisions according to recognised risk-based principles.^{3,5} Nodule size was grouped as less than 2 cm, 2–4 cm and greater than 4 cm.

Thyroid function testing

Venous samples were collected before FNAC or definitive intervention. Serum TSH, fT4 and fT3 were measured by chemiluminescent immunoassay and interpreted using institutional reference intervals. Euthyroidism required TSH and free hormones within range. Subclinical hypothyroidism was defined as elevated TSH with normal fT4, and overt hypothyroidism as elevated TSH with reduced fT4. Subclinical hyperthyroidism comprised suppressed TSH with normal free hormones; overt hyperthyroidism comprised suppressed TSH with elevated fT4 and/or fT3.

Fine-needle aspiration cytology

FNAC was performed aseptically with a 23–25-gauge needle and ultrasound guidance when indicated. Air-dried and alcohol-fixed smears were stained by May–Grünwald–Giemsa and Papanicolaou methods. Cytology was assigned to Bethesda categories I–VI.⁶ Category II was considered benign and categories III–VI non-benign for association analysis. Category I specimens were excluded because no definitive cytological classification was available.

Bias

Several measures were adopted to minimise potential sources of bias. Selection bias was reduced by consecutive recruitment of eligible patients and application of predefined inclusion and exclusion criteria rather than selective enrolment. To limit measurement bias, thyroid function testing was performed using a standardised chemiluminescent immunoassay and interpreted according to institutional reference intervals. Venous samples were collected before FNAC or definitive intervention to maintain consistency in biochemical assessment. FNAC specimens were processed using standard staining techniques and classified according to the internationally recognised Bethesda System for Reporting Thyroid Cytopathology, thereby reducing variability in cytological categorisation.

A structured data-collection form was used for recording demographic and clinical information to minimise inconsistencies in data collection. Ultrasonographic assessment was used to document nodule characteristics and support decisions regarding aspiration. In patients with multinodular thyroid disease, the dominant or sonographically most relevant nodule was selected according to a predefined approach, reducing variability in lesion selection. Patients with incomplete thyroid function data and non-diagnostic Bethesda category I specimens were excluded from analyses requiring definitive cytological classification. Nevertheless, because this was a single-centre, hospital-based cross-sectional study, referral bias, residual confounding and limited generalisability cannot be completely excluded.

Statistical analysis

Continuous variables were summarised as mean $\pm$ standard deviation or median with interquartile range. Categorical variables were reported as number and percentage. Chi-

square or Fisher's exact tests assessed categorical associations. TSH distributions were compared using the Kruskal–Wallis test, and ordered Bethesda categories were examined with Spearman's correlation. Odds ratios with 95% confidence intervals were calculated. A two-sided $p < 0.05$ indicated statistical significance. Statistical software details should be inserted by the authors.

Ethical considerations

Ethical approval for the study was obtained from the Institutional Ethics Committee of Government Medical College and Hospital, Vikarabad, Telangana, India, before initiation of the study. Written informed consent was obtained from all participants prior to enrolment.

Results

Participant recruitment and baseline characteristics

A total of 86 patients with clinically or radiologically detected thyroid nodules were assessed for eligibility. Six were excluded: two had undergone previous thyroid surgery, two were receiving long-term thyroid-specific treatment, one had incomplete thyroid function test results, and one declined fine-needle aspiration cytology. The remaining 80 patients were included in the final analysis, and complete clinical, biochemical, and cytological data were available for all participants.

The mean age of the study population was 44.8 ± 13.2 years (range, 19–72 years). Most participants were female (62/80, 77.5%), yielding a female-to-male ratio of 3.4:1. A solitary thyroid nodule was present in 49 patients (61.3%), whereas 31 (38.8%) had a dominant nodule within a multinodular gland. The mean maximum nodule diameter was 2.6 ± 1.3 cm. Neck swelling was the most common presenting feature, followed by dysphagia, local pain or discomfort, and voice change (Table 1).

Table 1: Baseline Demographic and Clinical Characteristics of the Study Population

Characteristic	Value
Total participants	80
Age, years	44.8 ± 13.2
Age <30 years	12 (15.0%)
Age 30–49 years	36 (45.0%)
Age ≥ 50 years	32 (40.0%)
Female	62 (77.5%)
Male	18 (22.5%)
Solitary thyroid nodule	49 (61.3%)
Dominant nodule in multinodular gland	31 (38.8%)
Maximum nodule diameter, cm	2.6 ± 1.3
Nodule diameter <2 cm	23 (28.8%)
Nodule diameter 2–4 cm	42 (52.5%)
Nodule diameter >4 cm	15 (18.8%)
Neck swelling	68 (85.0%)
Dysphagia	12 (15.0%)

Characteristic	Value
Local pain or discomfort	6 (7.5%)
Voice change	3 (3.8%)

Note. Values are presented as mean $\pm$ standard deviation or number (percentage), as appropriate.

Thyroid function profile

The median serum thyroid-stimulating hormone (TSH) concentration was 2.8 mIU/L (interquartile range [IQR], 1.4–5.1 mIU/L). Mean free thyroxine (fT4) and free

triiodothyronine (fT3) concentrations were 1.12 ± 0.31 ng/dL and 3.05 ± 0.74 pg/mL, respectively. Fifty patients (62.5%) were euthyroid. Hypothyroid biochemical patterns were identified in 21 patients (26.3%), comprising 14 (17.5%) with subclinical hypothyroidism and 7 (8.8%) with overt hypothyroidism. Nine patients (11.3%) had a hyperthyroid biochemical pattern, including 5 (6.3%) with subclinical hyperthyroidism and 4 (5.0%) with overt hyperthyroidism (Table 2).

Table 2: *Distribution of Thyroid Function Patterns*

Thyroid function pattern	n (%)
Euthyroid	50 (62.5%)
Subclinical hypothyroidism	14 (17.5%)
Overt hypothyroidism	7 (8.8%)
Subclinical hyperthyroidism	5 (6.3%)
Overt hyperthyroidism	4 (5.0%)
Total	80 (100.0%)

Cytological patterns of thyroid nodules

Bethesda category II was the most frequent cytological classification, observed in 52 nodules (65.0%). Among these benign lesions, colloid goitre was the predominant diagnosis (31/80, 38.8%), followed by nodular goitre (10/80, 12.5%), lymphocytic thyroiditis (8/80, 10.0%), and benign follicular nodules (3/80, 3.8%). Four aspirates

(5.0%) were classified as Bethesda category I because they were non-diagnostic or unsatisfactory. Bethesda categories III and IV were identified in 8 (10.0%) and 6 (7.5%) patients, respectively. Four patients (5.0%) had cytology suspicious for malignancy (Bethesda V), whereas 6 (7.5%) had malignant cytology (Bethesda VI), including 5 papillary thyroid carcinomas and 1 medullary thyroid carcinoma. Overall, 10 patients (12.5%) had Bethesda category V or VI cytology (Table 3).

Table 3: *Distribution of Thyroid Nodules According to the Bethesda System for Reporting Thyroid Cytopathology*

Bethesda category	Cytological interpretation	n (%)
I	Non-diagnostic or unsatisfactory	4 (5.0%)

Bethesda category	Cytological interpretation	n (%)
II	Benign	52 (65.0%)
III	Atypia of undetermined significance	8 (10.0%)
IV	Follicular neoplasm/suspicious for follicular neoplasm	6 (7.5%)
V	Suspicious for malignancy	4 (5.0%)
VI	Malignant	6 (7.5%)
Total		80 (100.0%)

Relationship between thyroid function and cytological pattern

Serum TSH concentrations differed significantly across cytological risk groups. The median TSH concentration was 2.3 mIU/L (IQR, 1.2–4.0 mIU/L) among patients with benign cytology, 4.1 mIU/L (IQR, 2.3–6.8 mIU/L) among those with Bethesda categories III–V, and 4.8 mIU/L (IQR, 2.7–7.2 mIU/L) among patients with malignant cytology.

The overall difference was statistically significant (Kruskal–Wallis $p = .006$).

For categorical risk analysis, the four patients with Bethesda category I cytology were excluded because their aspirates were non-diagnostic. All eight evaluable nodules in patients with suppressed TSH had benign cytology. Non-benign cytology was identified in 13 of 48 patients (27.1%) with normal TSH and in 11 of 20 patients (55.0%) with elevated TSH. The proportion of non-benign cytology increased significantly across suppressed, normal, and elevated TSH categories, $\chi^2(2) = 9.22$, $p = .010$ (Table 4).

Table 4: Association Between Serum TSH Category and Cytological Risk

Serum TSH category	Benign cytology, n (%)	Non-benign cytology, n (%)	Total
Suppressed TSH	8 (100.0%)	0 (0.0%)	8
Normal TSH	35 (72.9%)	13 (27.1%)	48
Elevated TSH	9 (45.0%)	11 (55.0%)	20
Total	52 (68.4%)	24 (31.6%)	76

Note. Non-benign cytology comprised Bethesda categories III–VI. Four patients with Bethesda category I cytology were excluded from this analysis. TSH = thyroid-stimulating hormone.

Patients with elevated TSH had approximately fourfold higher odds of non-benign cytology than those with normal or suppressed TSH concentrations combined (odds ratio =

4.04, 95% CI [1.38, 11.87], Fisher's exact $p = .012$). Serum TSH also showed a weak-to-moderate positive correlation with increasing Bethesda category (Spearman's $\rho = .31$, $p = .006$). By contrast, neither ft4 nor ft3 was significantly associated with cytological risk ($p = .184$ and $p = .237$, respectively).

Thyroid dysfunction within individual cytological patterns

Euthyroidism remained the predominant biochemical pattern among patients with benign, indeterminate, and malignant nodules. Hypothyroidism was particularly frequent among patients with lymphocytic thyroiditis: 5 of

8 had subclinical hypothyroidism, 2 had overt hypothyroidism, and 1 was euthyroid. Hyperthyroid biochemical patterns occurred mainly among patients with colloid or nodular goitre. Of the nine patients with suppressed TSH, eight had evaluable benign cytology and one had non-diagnostic cytology. No evaluable patient with suppressed TSH had Bethesda category III–VI cytology.

Association of demographic and nodule characteristics with cytological risk

Non-benign cytology tended to occur more frequently among patients aged 50 years or older and among those with nodules larger than 4 cm; however, neither association reached statistical significance ($p = .272$ and $p = .168$, respectively). Cytological risk was also not significantly associated with sex ($p = .420$) or with solitary versus multinodular presentation ($p = .536$).

Discussion

This study evaluated thyroid function and FNAC patterns in 80 patients with thyroid nodules. Women formed more than three-quarters of the cohort, and the mean age was in the mid-forties. This profile reflects the established epidemiology of nodular thyroid disease, which is detected more often in women and increases with age.¹ A solitary nodule occurred in 61.3%, while neck swelling was the leading presentation. These findings are consistent with a hospital-based population enriched for clinically apparent lesions.

Benign cytology was predominant, with Bethesda category II accounting for 65.0% of nodules. Colloid goitre was the commonest diagnosis, followed by nodular goitre and lymphocytic thyroiditis. The non-diagnostic rate was 5.0%, malignant cytology occurred in 7.5%, and categories V–VI together represented 12.5%. The Bethesda framework therefore separated a large benign group from nodules requiring repeat sampling, surveillance or surgical

assessment.⁶ This distribution is broadly compatible with meta-analytic evidence showing that most aspirated nodules are benign and that Bethesda classification provides a high negative predictive value.⁷

The main finding was a graded increase in serum TSH across cytological risk groups. Median TSH increased from 2.3 mIU/L in benign nodules to 4.1 mIU/L in categories III–V and 4.8 mIU/L in malignant cytology. Elevated TSH was associated with approximately fourfold higher odds of non-benign cytology. This agrees with observations by Boelaert,⁸ Haymart,⁹ Polyzos¹⁰ and Golbert,¹¹ who reported higher TSH concentrations in malignant or higher-risk nodules. TSH receptor activation and downstream cyclic adenosine monophosphate signalling provide a plausible trophic mechanism. Nonetheless, these cross-sectional findings demonstrate association, not causation; TSH remains an adjunct to ultrasound and cytology.

Free thyroid hormone concentrations were not significantly associated with cytological risk. Gul and colleagues reported lower fT3 and fT4 concentrations in malignant disease despite values within reference intervals.¹² Differences in assay characteristics, population selection, sample size and the use of cytology rather than final histopathology could explain the discrepancy. Non-benign cytology was numerically more frequent in older adults, males and nodules larger than 4 cm, but these differences were not significant. Larger datasets have linked male sex and solitary nodularity with papillary carcinoma risk,¹³ indicating limited precision for secondary comparisons in the present sample.

Generalizability

The findings are most applicable to adults presenting with clinically apparent or ultrasound-detected thyroid nodules in tertiary-care hospitals with access to thyroid function testing and standardised FNAC reporting. Consecutive recruitment and complete biochemical and cytological data strengthen internal consistency. Nevertheless, referral patterns, regional iodine status, laboratory reference intervals and local thresholds for aspiration can influence case mix. Multicentre studies including community-detected nodules and histopathological follow-up would provide broader external validity.

Conclusion

In this hospital-based study, most thyroid nodules occurred in women, presented as solitary lesions and demonstrated benign Bethesda category II cytology. Euthyroidism was the commonest biochemical state, although hypothyroid patterns affected approximately one-quarter of participants. Serum TSH showed a significant graded relationship with cytological risk, and elevated TSH was associated with fourfold higher odds of Bethesda category III–VI cytology. Free triiodothyronine and free thyroxine were not significantly related to cytological classification. These findings support serum TSH as a readily available adjunct for risk assessment within routine clinical practice. It should be interpreted together with clinical features, ultrasound findings and FNAC rather than used independently to determine malignancy or treatment.

Limitations

The single-centre design and sample size restricted the precision of subgroup comparisons. Cytological classification, rather than postoperative histopathology, was the principal outcome, so definitive malignancy rates were unavailable for indeterminate categories. Thyroid autoantibodies, iodine status, detailed ultrasound risk scores and molecular markers were not assessed. Residual confounding from unmeasured clinical factors remains possible, and the cross-sectional design prevents temporal or causal interpretation.

Recommendations

Routine evaluation of thyroid nodules should combine serum TSH, high-quality ultrasonography and Bethesda-standardised FNAC reporting. Patients with elevated TSH and Bethesda category III–VI cytology should receive timely specialist review, with repeat aspiration, molecular testing or surgery selected according to the complete risk profile. Future research should use multicentre prospective designs, larger samples and histopathological confirmation to determine whether TSH improves established ultrasound-cytology prediction models. Thyroid autoantibodies, iodine exposure and laboratory-specific reference intervals should be incorporated across diverse regional clinical contexts. Longitudinal follow-up is also required to clarify whether changes in thyroid function correspond with nodule progression or cytological reclassification.

Acknowledgement

The authors acknowledge the support of the Departments of General Medicine, Pathology, Radiodiagnosis and Biochemistry at Government Medical College and Hospital, Vikarabad. Appreciation is extended to the laboratory personnel, nursing staff and all study participants whose cooperation enabled completion of the clinical, biochemical and cytological assessments included in this study.

Abbreviations

ACR-American College of Radiology;
FNAC-Fine-Needle Aspiration Cytology;
fT3-free triiodothyronine;
fT4-free thyroxine;
STROBE-Strengthening the Reporting of Observational Studies in Epidemiology;
TSH-Thyroid-stimulating hormone;
TI-RADS-Thyroid Imaging Reporting and Data System.
IQR- Interquartile Range

Source of funding

The study had no funding.

Conflict of interest

The authors declare no conflict of interest.

Author contributions

SS-Concept and design of the study, results interpretation, review of literature and preparing first draft of manuscript. Statistical analysis and interpretation, revision of manuscript. **NS**- design of the study, results interpretation, review of literature and preparing first draft of manuscript. Statistical analysis and interpretation, revision of manuscript. **RS**- Results interpretation, review of literature and preparing first draft of manuscript. Statistical analysis and interpretation, revision of manuscript

Data availability

Data available on request

Author Biography

Page | 9

Dr. Sailusha Sreerama is an Assistant Professor in the Department of Biochemistry at Government Medical College, Vikarabad, Telangana, India. Her academic and research interests include clinical biochemistry, metabolic disorders, laboratory diagnostics, and biochemical markers relevant to disease evaluation and prognosis. She is actively involved in undergraduate medical education and research activities. **ORCID iD** : <https://orcid.org/0009-0003-0698-5584>

Dr. Nadera Sultana is an Assistant Professor in the Department of Pathology at Government Medical College, Vikarabad, Telangana, India. Her professional interests include histopathology, cytopathology, clinicopathological correlation, and diagnostic pathology. She is engaged in medical teaching, diagnostic services, and research in pathological mechanisms of human disease. **ORCID iD** : <https://orcid.org/0009-0005-2898-0236>

Dr. Rama Shouri is Professor and Head of the Department of Biochemistry at Government Medical College, Vikarabad, Telangana, India. She has extensive experience in medical education, clinical biochemistry, laboratory medicine, and academic research. Her areas of interest include biochemical diagnostics, metabolic and hepatic disorders, interpretation of laboratory biomarkers, and mentoring of undergraduate and postgraduate research.

References

1. Dean DS, Gharib H. Epidemiology of thyroid nodules. *Best Pract Res Clin Endocrinol Metab.* 2008;22(6):901-911. <https://doi.org/10.1016/j.beem.2008.09.019>
2. Hegedüs L. Clinical practice. The thyroid nodule. *N Engl J Med.* 2004;351(17):1764-1771. <https://doi.org/10.1056/NEJMc031436>
3. Haugen BR, Alexander EK, Bible KC, Doherty GM, Mandel SJ, Nikiforov YE, et al. 2015 American Thyroid Association management guidelines for adult patients with thyroid nodules and differentiated thyroid cancer. *Thyroid.* 2016;26(1):1-133. doi:10.1089/thy.2015.0020. <https://doi.org/10.1089/thy.2015.0020>
4. Durante C, Grani G, Lamartina L, Filetti S, Mandel SJ, Cooper DS. The diagnosis and management of thyroid nodules: a review. *JAMA.* 2018;319(9):914-924. doi:10.1001/jama.2018.0898. <https://doi.org/10.1001/jama.2018.0898>
5. Tessler FN, Middleton WD, Grant EG, Hoang JK, Berland LL, Teefey SA, et al. ACR Thyroid Imaging, Reporting and Data System (TI-RADS): white paper of the ACR TI-RADS Committee. *J Am Coll Radiol.* 2017;14(5):587-595. doi:10.1016/j.jacr.2017.01.046. <https://doi.org/10.1016/j.jacr.2017.01.046>
6. Ali SZ, Baloch ZW, Cochand-Priollet B, Schmitt FC, Vielh P, VanderLaan PA. The 2023 Bethesda System for Reporting Thyroid Cytopathology. *Thyroid.* 2023;33(9):1039-1044. <https://doi.org/10.1089/thy.2023.0141>
7. Bongiovanni M, Spitale A, Faquin WC, Mazzucchelli L, Baloch ZW. The Bethesda System for Reporting Thyroid Cytopathology: a meta-analysis. *Acta Cytol.* 2012;56(4):333-339. doi:10.1159/000339959. <https://doi.org/10.1159/000339959>
8. Boelaert K, Horacek J, Holder RL, Watkinson JC, Sheppard MC, Franklyn JA. Serum thyrotropin concentration as a novel predictor of malignancy in thyroid nodules investigated by fine-needle aspiration. *J Clin Endocrinol Metab.* 2006;91(11):4295-4301. <https://doi.org/10.1210/jc.2006-0527>
9. Haymart MR, Repplinger DJ, Levenson GE, Elson DF, Sippel RS, Jaume JC, et al. Higher serum thyroid stimulating hormone level in thyroid nodule patients is associated with greater risks of differentiated thyroid cancer and advanced tumor stage. *J Clin Endocrinol Metab.* 2008;93(3):809-814. <https://doi.org/10.1210/jc.2007-2215>
10. Polyzos SA, Kita M, Efsthadiadou Z, Poulakos P, Slavakis A, Sofianou D, et al. Serum thyrotropin concentration as a biochemical predictor of thyroid malignancy in patients presenting with thyroid nodules. *J Cancer Res Clin Oncol.*

2008;134(9):953-960.

<https://doi.org/10.1007/s00432-008-0373-7>

11. Golbert L, de Cristo AP, Faccin CS, Farenzena M, Folgieri H, Graudenz MS, et al. Serum TSH levels as a predictor of malignancy in thyroid nodules: a prospective study. PLoS One. 2017;12(11):e0188123.

<https://doi.org/10.1371/journal.pone.0188123>

12. Gul K, Ozdemir D, Dirikoc A, Oguz A, Tuzun D, Baser H, et al. Are endogenously lower serum thyroid hormones new predictors for thyroid malignancy in addition to higher serum thyrotropin? Endocrine. 2010;37(2):253-260.

<https://doi.org/10.1007/s12020-010-9316-6>

13. Rago T, Fiore E, Scutari M, Santini F, Di Coscio G, Romani R, et al. Male sex, single nodularity, and young age are associated with the risk of finding a papillary thyroid cancer on fine-needle aspiration cytology in a large series of patients with nodular thyroid disease. Eur J Endocrinol. 2010;162(4):763-770.

<https://doi.org/10.1530/EJE-09-0895>

14. von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP; STROBE Initiative. The Strengthening the Reporting of Observational Studies in Epidemiology statement: guidelines for reporting observational studies. Lancet. 2007;370(9596):1453-1457.

[https://doi.org/10.1016/S0140-6736\(07\)61602-X](https://doi.org/10.1016/S0140-6736(07)61602-X)

Publisher details

Student's Journal of Health Research (SJHR)

(ISSN 2709-9997) Online

(ISSN 3006-1059) Print

Category: Non-Governmental & Non-profit Organization

Email: studentsjournal2020@gmail.com

WhatsApp: +256 775 434 261

Location: Scholar's Summit Nakigalala, P. O. Box 701432, Entebbe Uganda, East Africa

