DOI: 10.4274/forbes.galenos.2026.69345
Forbes J Med 2026;7:107-114

Original Article

Preoperative Clinical Factors Associated with High-Risk Thyroid Cytology (Bethesda V-VI): A Retrospective Study of a Thyroidectomy Cohort

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Cite as: Bayar B, Türk Y. Preoperative clinical factors associated with high-risk thyroid cytology (Bethesda V-VI): a retrospective study of a thyroidectomy cohort. Forbes J Med. 2026;7:107-114

ABSTRACT

Objective: To identify preoperative clinical factors associated with high-risk thyroid cytology (Bethesda V–VI) in patients undergoing thyroidectomy and to explore their association with cytological reclassification in initially non-high-risk nodules.

Methods: In this single-center retrospective study, 438 consecutive patients undergoing thyroidectomy between 2024 and 2025 were evaluated. After excluding Bethesda I cases, 415 patients were included in the analysis. High-risk cytology (Bethesda V-VI) was the primary outcome. Age, sex, nodule size, bilateral involvement, toxic functional status, and cervical lymphadenopathy (LAP) were evaluated by logistic regression analysis. A prespecified sensitivity analysis was restricted to Bethesda V cytology.

Results: High-risk cytology was identified in 151 patients (36.4%). In multivariable analysis, toxic functional status [odds ratio (OR), 0.20; 95% confidence interval (CI), 0.07-0.54; p=0.002] and larger nodule size (OR, 0.21; 95% CI, 0.15-0.30; p<0.001) were independently associated with lower odds of high-risk cytology, whereas LAP was associated with higher odds of high-risk cytology (OR, 4.17; 95% CI, 1.87-9.31; p<0.001). No independent associations were observed for age, sex, or bilaterality. The associations with toxic functional status and nodule size remained consistent in the sensitivity analysis. Among 127 patients who underwent repeat fine-needle aspiration, 19 (15.0%) were reclassified as having high-risk cytology, with consistent findings.

Conclusion: Toxic functional status was associated with a lower likelihood of high-risk thyroid cytology, whereas LAP was associated with a higher likelihood of high-risk thyroid cytology. Similar patterns among patients undergoing repeat aspiration suggest that these routinely available clinical features may inform follow-up decisions for nodules initially classified as non-high-risk. Prospective studies are warranted to validate these findings.

Keywords: Thyroid nodule, Bethesda classification, thyroid fine-needle aspiration, high-risk thyroid cytology, cervical lymphadenopathy

Received: 12.06.2026
Accepted: 21.08.2026
Epub: 25.08.2026
Publication Date: 03.09.2026

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INTRODUCTION

Thyroid nodules are among the most common findings encountered in adult clinical practice, and their detection has increased substantially with the widespread use of high-resolution imaging modalities.[1] In recent years, a marked rise in the incidence of thyroid cancer has been reported, largely attributable to the increased detection of small and clinically indolent papillary carcinomas.[2,3] Consequently, the appropriate evaluation of thyroid nodules and the avoidance of unnecessary surgical interventions have become increasingly important in clinical practice.[4]

Fine-needle aspiration (FNA) cytology is the cornerstone of risk stratification for thyroid nodules.[4,5] Cytological findings are reported according to the Bethesda System for Reporting Thyroid Cytopathology, in which each diagnostic category is associated with a distinct risk of malignancy.[6,7] Bethesda categories V (suspicious for malignancy) and VI (malignant) represent the highest-risk groups and warrant surgical management in most cases.[6] Current clinical guidelines recommend that cytological findings be interpreted in conjunction with clinical and radiological features.[5,8]

Several clinical characteristics, including functional status, cervical lymphadenopathy (LAP), nodule size, age, and sex, have previously been investigated in relation to thyroid malignancy.[5,8,9] However, most existing studies have focused on histopathological malignancy as the primary outcome, whereas clinical factors associated specifically with high-risk cytological categories have received comparatively limited attention. Yet, in routine clinical practice, preoperative cytological classification constitutes one of the principal determinants guiding surgical decision-making.

Therefore, defining the clinical profile associated with high-risk thyroid cytology may facilitate treatment planning and improve follow-up strategies. Moreover, identifying such a profile may provide additional insight into which patients with nodules initially classified as non-high-risk cytology require closer surveillance during follow-up.

In this study, we aimed to identify preoperative clinical factors associated with high-risk thyroid cytology (Bethesda categories V-VI) in patients undergoing thyroidectomy.

In addition, we explored whether these same clinical characteristics were associated with cytological reclassification to high-risk cytology among nodules that were initially classified as non-high-risk and subsequently underwent repeat FNA.

METHODS

Study Design and Study Population

In this single-center retrospective study, 438 consecutive patients who underwent thyroidectomy between January 2024 and December 2025 were initially evaluated. After excluding 23 patients with Bethesda category I (non-diagnostic) cytology, the final analysis included 415 patients (Figure 1).

Variables and Definitions

Preoperative variables retrieved from the medical records included age, sex, nodule size category (<10 mm, 10-19 mm, 20-39 mm, and ≥40 mm), nodule distribution (unilateral or bilobar involvement), functional status (classified as toxic or non-toxic based on the presence of clinical and biochemical thyrotoxicosis), and LAP identified on preoperative ultrasonography.

LAP was defined as lymph nodes reported as pathological or suspicious on preoperative ultrasonography, based on radiological interpretation documented in the medical records.

In patients with multiple thyroid nodules, the index nodule was defined as the lesion that underwent FNA and exhibited the most suspicious ultrasonographic

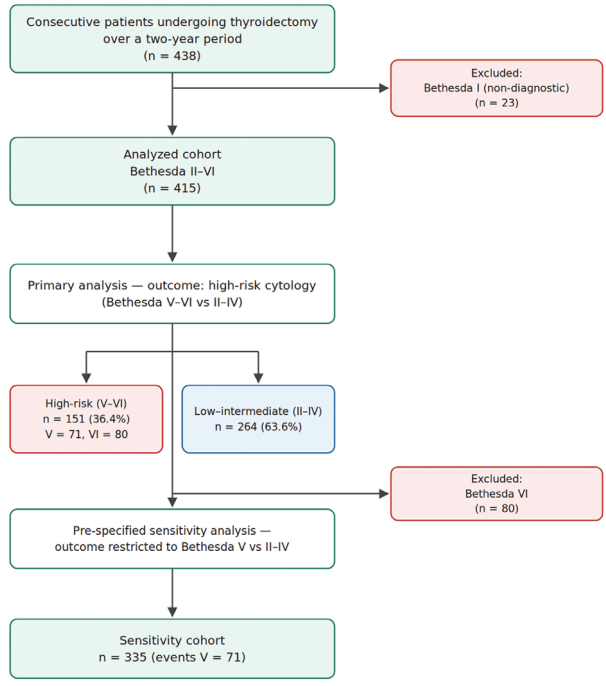

Figure 1. Study flow diagram. Of the 438 consecutive patients who underwent thyroidectomy during the study period, 23 cases reported as Bethesda category I (non-diagnostic/unsatisfactory) were excluded. Consequently, 415 patients were included in the primary analysis. High-risk cytology was defined as Bethesda categories V-VI, with Bethesda categories II-IV serving as the reference group

characteristics. Nodule-level variables were derived from the index nodule, whereas patient-level variables were obtained from the preoperative clinical records. FNA cytology results were classified according to the Bethesda System for Reporting Thyroid Cytopathology.[6]

Outcome Definition

The primary outcome of the study was the presence of high-risk thyroid cytology, defined as Bethesda categories V-VI, with Bethesda categories II-IV serving as the reference group. Bethesda categories V and VI were combined into a single outcome because of their similarly high-risks of malignancy and comparable clinical management, which typically involves surgical treatment. In contrast, Bethesda categories II-IV are generally managed with surveillance, repeat FNA, or surgery in selected cases. This classification strategy was adopted to focus on cytological risk categories that directly reflect preoperative clinical decision-making rather than postoperative histopathological outcomes.

Statistical Analysis

Continuous variables are presented as mean ± standard deviation or median (interquartile range), as appropriate, whereas categorical variables are expressed as frequencies and percentages. Comparisons between groups were performed using the independent-samples t-test, Mann-Whitney U test, or chi-square test, as appropriate.

Factors associated with high-risk thyroid cytology were first evaluated by univariable logistic regression, followed by multivariable logistic regression, with age, sex, nodule size category, bilateral involvement, functional status, and LAP included as covariates. Results are reported as odds ratios (ORs) with 95% confidence intervals (CIs).

Nodule size was entered into the regression models as an ordinal variable with four categories (<10 mm, 10-19 mm, 20-39 mm, and ≥40 mm), with the per-step estimate representing the change in odds across successively larger size categories. Standard logistic regression was used for the primary analysis, as the model yielded stable finite estimates with bounded CIs and showed no indication of separation.

Model performance was assessed using McFadden's pseudo-R^2, the area under the receiver operating characteristic curve (AUC), and the Hosmer-Lemeshow goodness-of-fit test, whereas multicollinearity was evaluated using the variance inflation factor (VIF). The trend in the prevalence of high-risk cytology across nodule size categories was examined using the Cochran-Armitage trend test.[10,11]

In a prespecified sensitivity analysis, Bethesda VI cases were excluded, and the multivariable analysis was repeated to compare Bethesda category V with Bethesda categories II-IV. Because only one patient with toxic functional status was present in the Bethesda V group, Firth's penalized logistic regression was also performed to evaluate the potential impact of sparse-data bias and quasi-complete separation.[12,13]

Internal model validity was assessed using bootstrap resampling and ten-fold cross-validation[14] (Supplementary Table 1). In addition, a sensitivity analysis excluding LAP from the multivariable model was conducted, and the AUCs of the two models were compared using the DeLong test[15] (Supplementary Table 2).

In a secondary exploratory analysis, patients who underwent repeat FNA were evaluated. Repeat aspirations were performed according to clinical indications and were identified retrospectively. Cytological progression was defined as reclassification from initially non-high-risk

Table 1. Clinical characteristics of the cohort according to cytology groups

Characteristic	Total (n=415)	High-risk (n=151)	Low-interm (n=264)	p
Age, years (mean ± SD)	48.1±13.5	46.1±13.4	49.3±13.5	0.020
Male sex, n (%)	110 (26.5%)	40 (26.5%)	70 (26.5%)	1.000
Toxic functional status, n (%)	86 (20.7%)	5 (3.3%)	81 (30.7%)	<0.001
Bilateral lobe involvement, n (%)	307 (74.0%)	96 (63.6%)	211 (79.9%)	<0.001
Cervical lymphadenopathy, n (%)	64 (15.4%)	48 (31.8%)	16 (6.1%)	<0.001
Nodule size category (median)	3	1	3	<0.001

Data are presented as mean ± standard deviation (SD), median, or number (%), as appropriate. Nodule size categories were coded as follows: 1, <10 mm; 2, 10-19 mm; 3, 20-39 mm; and 4, ≥40 mm. Median values represent the median nodule size category within each group. The high-risk cytology group comprised Bethesda categories V-VI, whereas the low-to-intermediate risk cytology group comprised Bethesda categories II-IV. Bethesda category I (non-diagnostic/unsatisfactory) cases were excluded from the analysis

Table 2. Univariable and multivariable logistic regression analyses for high-risk cytology (Bethesda V-VI)

Variable	Univariable OR (95% CI); p	Multivariable OR (95% CI); p
Toxic functional status (vs. non-toxic)	0.08 (0.03-0.20); <0.001	**0.20 (0.07-0.54); 0.002**
Cervical lymphadenopathy (present vs. absent)	7.22 (3.92-13.30); <0.001	**4.17 (1.87-9.31); <0.001**
Nodule size category (per step)	0.19 (0.14-0.26); <0.001	**0.21 (0.15-0.30); <0.001**
Male sex (vs. female)	1.00 (0.63-1.57); 0.996	1.87 (0.97-3.62); 0.063
Age (per year)	0.98 (0.97-1.00); 0.021	1.00 (0.98-1.02); 0.790
Bilateral involvement (vs. unilateral)	0.44 (0.28-0.69); <0.001	0.71 (0.37-1.35); 0.298

The outcome was high-risk cytology (Bethesda V-VI), with Bethesda II-IV categories serving as the reference group. Nodule size was modeled as an ordinal variable (<10 mm, 10-19 mm, 20-39 mm, and ≥40 mm). Bold values indicate statistical significance in the multivariable analysis. OR: Odds ratio, CI: Confidence interval

cytology (Bethesda II-IV) to high-risk cytology (Bethesda V-VI) on any subsequent aspiration. Baseline clinical characteristics were compared between patients with and without cytological progression using Fisher's exact test and the Mann-Whitney U test.

All statistical tests were two-sided, and a p value <0.05 was considered statistically significant. All analyses were performed in the Python 3 environment using the statsmodels package.

This study was designed and reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology guidelines.[16]

The study protocol was approved by the Ankara Etlik City Hospital Scientific Research Evaluation and Ethics Committee (approval no: AEŞH-BADEK2-2026-495, date: June 9, 2026). In accordance with the committee's decision and owing to the retrospective study design, the requirement for informed consent was waived.

RESULTS

Baseline Characteristics of the Cohort

Of the 415 patients included in the analysis, 305 (73.5%) were female, and the mean age was 48.1±13.5 years. High-risk thyroid cytology (Bethesda categories V-VI) was identified in 151 patients (36.4%). The distribution of cytological diagnoses was as follows: Bethesda II, 115 patients; Bethesda III, 109 patients; Bethesda IV, 40 patients; Bethesda V, 71 patients; and Bethesda VI, 80 patients. Twenty-three patients with Bethesda category I cytology (non-diagnostic) were excluded from the analysis (Supplementary Table 3).

Compared with the non-high-risk group, patients with high-risk cytology had a lower prevalence of toxic functional status and bilateral involvement, but a higher prevalence of cervical LAP. The distribution of nodule size categories also differed between the two groups. The demographic and clinical characteristics of the study population are summarized in Table 1.

Univariable and Multivariable Analyses

In the univariable logistic regression analysis, toxic functional status, cervical LAP, nodule size, bilateral involvement, and age were significantly associated with high-risk thyroid cytology (Table 2).

In the multivariable model, toxic functional status (OR, 0.20; 95% CI, 0.07-0.54; p=0.002) and larger nodule size (OR, 0.21; 95% CI, 0.15-0.30; p<0.001) were independently associated with lower odds of high-risk cytology, whereas LAP remained independently associated with higher odds (OR, 4.17; 95% CI, 1.87-9.31; p<0.001). Male sex, age, and bilateral involvement were not independently associated with the outcome (Table 2 and Figure 2). A progressive decline in the prevalence of high-risk cytology across

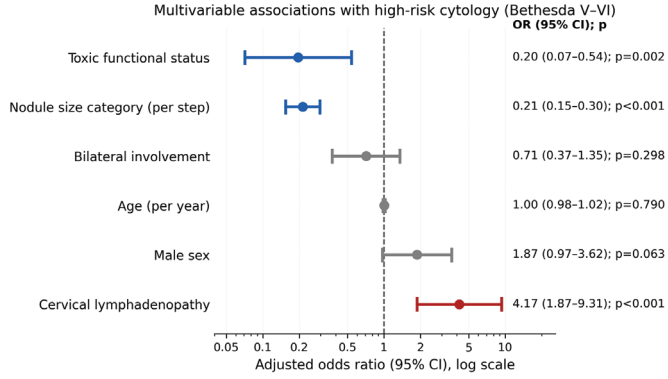

Figure 2. Forest plot of multivariable associations with high-risk cytology. Points represent adjusted odds ratios (ORs), and horizontal lines indicate 95% confidence intervals (CIs). The dashed vertical line represents the null value (OR =1). Colors are used for visual distinction only (red: OR >1, blue: OR <1, gray: not statistically significant)

Table 3. Sensitivity analysis (Bethesda V vs. Bethesda II-IV): standard vs. Firth penalized logistic regression (n=335; 71 events)

	Standard logistic OR (95% CI)	p	Firth penalized OR (95% PL CI)	p
Toxic functional status (vs. non-toxic)	0.07 (0.01-0.51)	0.009	**0.10 (0.01-0.41)**	**<0.001**
Cervical lymphadenopathy (present vs. absent)	2.39 (0.91-6.29)	0.078	2.32 (0.90-6.06)	0.081
Nodule size category (per step)	0.25 (0.17-0.36)	<0.001	**0.26 (0.18-0.37)**	**<0.001**
Male sex (vs. female)	2.04 (0.92-4.55)	0.081	2.00 (0.92-4.43)	0.082
Age (per year)	1.00 (0.98-1.03)	0.725	1.00 (0.98-1.03)	0.737
Bilateral involvement (vs. unilateral)	0.88 (0.41-1.87)	0.736	0.87 (0.42-1.85)	0.720

The outcome was Bethesda V cytology versus Bethesda II-IV cytology. OR <1 indicates lower odds and OR >1 indicates higher odds of Bethesda V cytology. Because only one patient with toxic functional status had Bethesda V cytology, Firth penalized logistic regression was performed to address potential sparse-data bias and quasi-separation. The direction and statistical significance of the associations were preserved in the Firth model. Bold values indicate statistical significance. OR: Odds ratio, CI: Confidence interval, PL CI: Profile likelihood CI

increasing nodule size categories was also observed in the unadjusted data (Supplementary Figure 1).

Sensitivity Analysis

To evaluate the influence of Bethesda category VI on the primary findings, the multivariable model was reconstructed to compare Bethesda category V with Bethesda categories II-IV only (n=335; 71 events). In this analysis, the associations of toxic functional status (OR, 0.07; 95% CI, 0.01-0.51; p=0.009) and nodule size (OR, 0.25; 95% CI, 0.17-0.36; p<0.001) with high-risk cytology remained significant. In contrast, the association between LAP and high-risk cytology no longer reached statistical significance (OR, 2.39; 95% CI, 0.91-6.29; p=0.078) (Table 3).

Because only one patient with toxic functional status was included in the Bethesda V group, Firth penalized logistic regression was applied as an additional analysis. The results were consistent with those of the standard logistic regression model, confirming an inverse association between toxic functional status and Bethesda V cytology (OR, 0.10; 95% CI, 0.01-0.41; p<0.001).

Sequential Cytological Evaluation (Exploratory Analysis)

Among the 127 patients with initially non-high-risk cytology (Bethesda II-IV) who underwent repeat FNA, 19 (15.0%) were subsequently reclassified as having high-risk cytology (Bethesda categories V-VI).

Patients who progressed to the high-risk category had a lower prevalence of toxic functional status [2/19 (11%) vs. 36/108 (33%); p=0.057], smaller nodules (median, 17 mm vs. 26 mm; p=0.002), and a higher prevalence of LAP [4/19 (21%) vs. 5/108 (5%); p=0.028]. No significant differences were observed with respect to sex, age, or bilateral involvement (all p>0.10; Supplementary Table 4).

Model Performance and Internal Validation

The multivariable model demonstrated excellent overall performance, with a McFadden pseudo-R^2 of 0.42 and an AUC of 0.90 (95% CI, 0.87-0.93; Supplementary Figure 2). Model calibration was satisfactory according to the Hosmer-Lemeshow goodness-of-fit test (χ^2=8.67, df=8, p=0.37). All VIF values were below 1.2, indicating no evidence of multicollinearity. The results of the internal validation analyses are presented in Supplementary Table 1; the findings from the sensitivity analysis excluding LAP from the multivariable model are presented in Supplementary Table 2.

DISCUSSION

In this study, we evaluated preoperative clinical factors associated with high-risk thyroid cytology (Bethesda categories V-VI) in patients undergoing thyroidectomy. Toxic functional status and larger nodule size were inversely associated with high-risk cytology, whereas LAP was independently associated with an increased likelihood of high-risk cytology. Importantly, the associations observed for toxic functional status and nodule size remained robust in the prespecified sensitivity analysis restricted to Bethesda category V. In contrast, the association with LAP was attenuated and no longer reached statistical significance, suggesting that this feature may have been concentrated primarily among patients in our cohort with Bethesda category VI cytology.

The inverse association between toxic functional status and high-risk cytology is biologically plausible and consistent with current clinical knowledge.[17] Hyperfunctioning thyroid nodules have long been recognized to carry a low-risk of malignancy, and contemporary guidelines do not recommend routine FNA for these lesions.[8,18] A systematic review and meta-analysis demonstrated that hot nodules have a substantially lower likelihood of malignancy than non-toxic nodules, with a pooled OR of approximately 0.45.[19] Our cytology-based findings agree with these histopathology-based observations and extend them by confirming the relationship at the level of high-risk cytological categories in a surgically treated cohort.

LAP was independently associated with high-risk cytology. This observation is consistent with current evidence recognizing suspicious cervical lymph nodes as markers of increased oncologic risk and highlights the importance of comprehensive preoperative neck ultrasonography in their assessment.[20,21] However, the association demonstrated in the present study pertains to high-risk cytological classification rather than histopathologically confirmed metastatic disease. Accordingly, LAP should be interpreted not as a direct indicator of malignancy, but as a clinical characteristic associated with high-risk thyroid cytology.

The prevalence of high-risk cytology in our cohort (36.4%) was considerably higher than the proportions of Bethesda V-VI categories typically reported in general FNA series, reflecting the fact that our study population consisted of patients who had already reached the threshold for surgical intervention and was therefore enriched for high-risk cytology.[7] The selected nature of the cohort is particularly relevant when interpreting the observed inverse association between nodule size and high-risk cytology. This finding likely reflects surgical selection rather than intrinsic tumor biology. Within surgical cohorts, smaller nodules are frequently selected for operation because of suspicious cytological findings, whereas larger nodules often undergo surgery because of compressive symptoms, cosmetic concerns, or progressive enlargement. This interpretation

is consistent with previous reports demonstrating that the relationship between nodule size and malignancy is heterogeneous and may not be linear.[22,23] Furthermore, verification bias is a well-recognized limitation of surgical series.[7,19] Even when histopathological malignancy is used as the endpoint, contemporary studies indicate that nodule size is not consistently associated with malignancy risk in operated or cytologically indeterminate cohorts and that preferential surgical selection of large nodules may bias outcomes toward benign histology.[23,24] These observations support our interpretation that the inverse association identified in the present study reflects surgical patient selection rather than tumor biology.

Although age was associated with high-risk cytology in the univariable analysis, it was no longer an independent predictor after multivariable adjustment.[25,26] Male sex was not significantly associated with the outcome in the univariable analysis but demonstrated a positive association, albeit of borderline statistical significance, in the adjusted model. Given the predominance of female patients in our cohort and the potential relationships between sex and variables such as toxic functional status and nodule size, this pattern may reflect residual confounding. The independent prognostic value of male sex remains controversial in the literature, and a substantial proportion of the observed excess risk has been attributed to other clinicopathological characteristics.[27]

Although Bethesda V-VI cytology generally leads directly to surgical management, defining the preoperative clinical profile associated with these categories may have practical implications because some thyroid nodules undergo serial cytological evaluation and lesions initially classified as benign or indeterminate may later be reclassified as suspicious or malignant. One novel aspect of the present study is the exploratory evaluation of the primary cross-sectional findings among patients who underwent repeat aspiration. Repeat FNA is well known to substantially modify the initial cytological classification. Approximately three-quarters of nodules initially reported as atypia of undetermined significance/follicular lesion of undetermined significance are reclassified on repeat aspiration, most commonly into a benign category, although a subset progresses to higher-risk categories.[28] Among patients with indeterminate cytology, the overall malignancy rate has been reported to be approximately 27.5%, and repeat aspiration has been recommended as a valuable step in selecting candidates for surgery.[29] In our cohort, 15.0% (19/127) of patients with initially non-high-risk cytology who underwent repeat FNA were subsequently reclassified as having high-risk cytology, consistent with previous reports. These patients exhibited smaller nodules, a lower prevalence of toxic functional status, and a higher prevalence of cervical LAP; notably, the direction of these associations was consistent with that observed in the primary cross-sectional analysis. Owing to the limited number of events, these findings should be considered hypothesis-generating rather than confirmatory. In a cytology-based study, reclassification does not necessarily reflect true biological progression, but may instead represent either correction of an initial false-negative aspiration or interobserver variability. Nevertheless, the practical implication is similar in either scenario: these routinely available clinical characteristics may help identify nodules that are subsequently upgraded to high-risk cytological categories and may therefore contribute to decisions regarding repeat aspiration or closer surveillance in patients whose initial cytology is not classified as high risk.[30] Importantly, the serial aspiration analysis was not fully independent of the primary cross-sectional cohort. Accordingly, these observations should be interpreted not as external validation but as internally consistent, hypothesis-generating findings within the same study population.

The clinical implications of these findings should be interpreted with appropriate caution. Toxic functional status appears to be a reassuring feature, whereas LAP warrants heightened clinical attention. However, these variables should not be considered substitutes for structured ultrasonographic risk stratification, cytological assessment, or molecular testing when indicated.[31,32] In particular, molecular classifiers such as the Afirma Gene Sequencing Classifier and ThyroSeq v3 have been shown to improve malignancy risk assessment in Bethesda III-IV nodules.[33,34] Our findings are consistent with current risk-based management strategies and provide additional clinical context that may complement these established approaches.

Study Limitations

The strengths of this study include its relatively large sample size, the use of multivariable analytical methods, the implementation of internal validation techniques, and the incorporation of an exploratory serial cytology analysis. In particular, the serial aspiration subgroup analysis provided an opportunity to investigate whether the clinical profile associated with high-risk cytology remained consistent in relation to cytological reclassification over time.

Several limitations should be acknowledged. First, this was a single-center retrospective study that included only patients undergoing thyroidectomy; therefore, its findings should be generalized to the broader population of patients with thyroid nodules with caution. Second, LAP was assessed solely by ultrasonography, and structured ultrasound risk-stratification systems and detailed

sonographic characteristics were not available for inclusion in the analyses. Third, the study was designed to identify clinical factors associated with high-risk cytological categories; therefore, the correlation between cytological categories and final histopathological findings was beyond the primary scope of this analysis. Fourth, repeat FNA analyses may have been subject to selection bias because repeat aspirations were performed according to clinical indications rather than a standardized follow-up protocol.

Finally, the limited number of events in the sensitivity analysis restricted to Bethesda category V resulted in relatively wide CIs for some estimates. Likewise, the excellent discriminative performance of the multivariable model (AUC, 0.90) may partly reflect the selected nature of this surgically-treated cohort.

Overall, in this cohort of patients undergoing thyroidectomy, several routinely available preoperative clinical characteristics consistently defined a profile associated with high-risk thyroid cytology (Bethesda categories V-VI). Within this profile, toxic functional status emerged as a reassuring feature, LAP represented a marker warranting greater clinical attention, and the inverse association observed with nodule size most likely reflected surgical patient selection rather than underlying tumor biology. The principal message of the present study is that this clinical profile extended beyond the initial surgical triage setting and demonstrated directional consistency among patients subsequently reclassified as having high-risk cytology following repeat aspiration. This consistency suggests that the identified clinical profile may complement cytological risk stratification, existing imaging and molecular diagnostic tools, and contribute to individualized decisions regarding surveillance intensity and repeat aspiration in patients with initially non-high-risk thyroid cytology. Nevertheless, these conclusions remain hypothesis-generating and require confirmation in larger, multicenter, prospective studies before they can be incorporated into routine clinical practice.

CONCLUSION

Toxic functional status and LAP emerged as the principal preoperative clinical features associated with high-risk thyroid cytology (Bethesda categories V-VI), with toxic functional status associated with a lower likelihood, and LAP associated with a higher likelihood, of high-risk cytology. The observation of similar association patterns among patients undergoing repeat FNA suggests that these readily available clinical characteristics may help identify nodules with initially non-high-risk cytology that warrant closer surveillance, repeat evaluation, or repeat aspiration during follow-up. However, these observations should be considered hypothesis-generating and require confirmation in prospective studies before being incorporated into routine clinical decision-making.

Ethics

Ethics Committee Approval: The study protocol was approved by the Ankara Etlik City Hospital Scientific Research Evaluation and Ethics Committee (approval no: AEŞH-BADEK2-2026-495, date: June 9, 2026).

Informed Consent: In accordance with the committee's decision and owing to the retrospective study design, the requirement for informed consent was waived.

Footnotes

Authorship Contributions

Surgical and Medical Practices: B.B., Y.T., Concept: B.B., Design: B.B., Data Collection or Processing: B.B., Y.T., Analysis or Interpretation: B.B., Y.T., Literature Search: B.B., Y.T., Writing: B.B., Y.T.

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: The authors declared that this study received no financial support.

Supplementary Tables: https://d2v96fxpocvxx.cloudfront.net/bda9171a-fae8-4995-8276-2138323f1e16/content-images/f3afe8f7-b0de-4199-8c31-52cb06fd1a30.pdf

Supplementary Figures: https://d2v96fxpocvxx.cloudfront.net/bda9171a-fae8-4995-8276-2138323f1e16/content-images/e1b3b4f9-140c-4e2f-a5d7-5b7a71f0f21e.pdf

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