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Systematic Review Article

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Risk Stratification for Thyroid Incidentalomas on PET/CT: Systematic Review and Meta-Analysis

Shamim Hyder [1], Nadha Rahim [1], Noula Rahim [2], Jamila Hameed [3]*

[1]Department of Radiology, Karuna Medical College, Vilayodi, Chittur, Palakkad, Kerala, India.
[2]Department of Biochemistry, Karuna Medical College, Vilayodi, Chittur, Palakkad, Kerala, India.
[3]Research Mentor, Karuna Medical College, Vilayodi, Chittur, Palakkad, Kerala, India.

*Corresponding Author: Jamila Hameed; *hameedjamila78@gmail.com*

Abstract

Background: Focal thyroid incidentalomas (FTIs) found on 18F-FDG PET/CT (Fluorine-18-Fluorodeoxyglucose Positoin Emission Tomography/Computed Tomography) examinations are becoming commonplace in routine clinical practice. While in most situations benign, a high percentage.***Objective and Aims:*** Establish the pooled prevalence and risk of malignancy of FTIs on PET/CT and define imaging and clinical risk markers of malignancy. Research questions: What is the malignant rate of FTIs recognized with 18F-FDG PET/CT, and what risk stratification factors are?***Methods***: PubMed, Scopus, and Web of Science were searched extensively to compile studies between 2015 and 2025. Included were studies that reported sample size and results in relation to malignancy. Data extraction and quality assessment were carried out with the Newcastle-Ottawa Scale. Random-effects meta-analysis was applied to establish pooled prevalence and 95% confidence intervals.***Results***: Ten studies with 2,500 patients were reviewed. The combined prevalence of FTIs was 2.5%, with an overall risk of malignancy of 30%. Elevated SUVmax (standardized uptake value), suspicious ultrasound morphology, and cytologic proof were reliable predictors of malignancy.***Conclusion***: FTIs on PET/CT carry high malignancy risk, necessitating systematic evaluation with combined metabolic, morphologic, and cytologic analysis. Reporting and risk stratification guidelines should be established. Prospective research should focus on development of AI-based predictive models and machine learning algorithms to enhance early detection and reduce unnecessary procedures.

Keywords: ***Focal thyroid incidentalomas, 18F-FDG PET/CT, malignancy risk, systematic review, meta-analysis, risk stratification.***

Introduction

Recognition of incidentalomas of the focal thyroid (FTIs) on 18F-FDG PET/CT imaging has also become a unique clinical issue with the increased application of PET imaging in oncology and in metabolic diseases. FTIs are unwanted thyroid gland lesions that develop during imaging performed under indications that bear no connection to thyroid disease, from benign nodules to potentially significant malignancies. With the growing prevalence of the application of PET imaging, incidental findings have gained increased prevalence and have become a diagnostic challenge in establishing the correct management and risk stratification (Cooper DS et al, 2009).

Precise characterization of FTIs is important since although most of them are benign, a considerable number could have papillary thyroid carcinoma (PTC) or other cancers, and so intervention at the correct time becomes important. Variables that affect malignancy risk include the standardized uptake value (SUVmax) on PET/CT, size of the nodule, sonographic characteristics, and cytologic findings on fine-needle aspiration (FNA). In spite of these measures, no criteria have been universally accepted to predict malignancy in incidental thyroid lesions, and so clinical management varies. It was also identified in a prospective study that 18F-FDG TIs in an uptake pattern, focal or diffuse/focal, correlated with thyroid malignancy in approximately one-third of the patients and were all primary thyroid malignancies, predominantly papillary carcinomas (Eren MŞ et al, 2016).

Many studies have shown that SUVmax thresholds in isolation are insufficient to conduct full risk stratification, hence the importance of integrating metabolic data with morphological characteristics and cytological confirmation. There was an overall moderate correlation between GLUT (glucose-transporter family) 1 expression and SUVs extracted from FDG-PET studies. Correlation coefficient was weaker in the case of GLUT 3. It is argued that the root causes of glucose hypermetabolism in tumours are Multi-factorial and not solely dependent on GLUT expression (Meyer HJ, 2019). Clinical parameters like patient age and sex and the primary indication of PET scanning may also influence the risk of malignancy (de Koster EJ et al, 2022). Hence, systematic tabulation of available data is needed to provide sound estimates of prevalence and risk of malignancy in addition to establishing predictors that are important in clinical decision-making.

These systematic review and meta-analysis have two primary goals: to assess the aggregate prevalence and risk of malignancy of FTIs identified on 18F-FDG PET/CT and to investigate imaging and clinical correlates of malignant transformation. By synthesizing data on studies published between

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2015 and 2025 and incorporating the latest available evidence published in 2025, this review hopes to inform guidelines based on evidence to guide diagnostic workup and follow-up. Furthermore, the identification of risk patterns and predictive factors hopes to assist clinicians in prioritizing high-risk lesions for biopsy while avoiding unnecessary intervention in the setting of benign findings. Finally, the results of this research wish to inform personalized, evidence-based approaches to patient management in the setting of PET-detected thyroid incidentalomas, enhancing outcomes and efficiency in clinical practice.

Methodology

This systematic review and meta-analysis was conducted following the PRISMA 2020 guidelines to ensure methodological rigor and transparency (Figure 1).

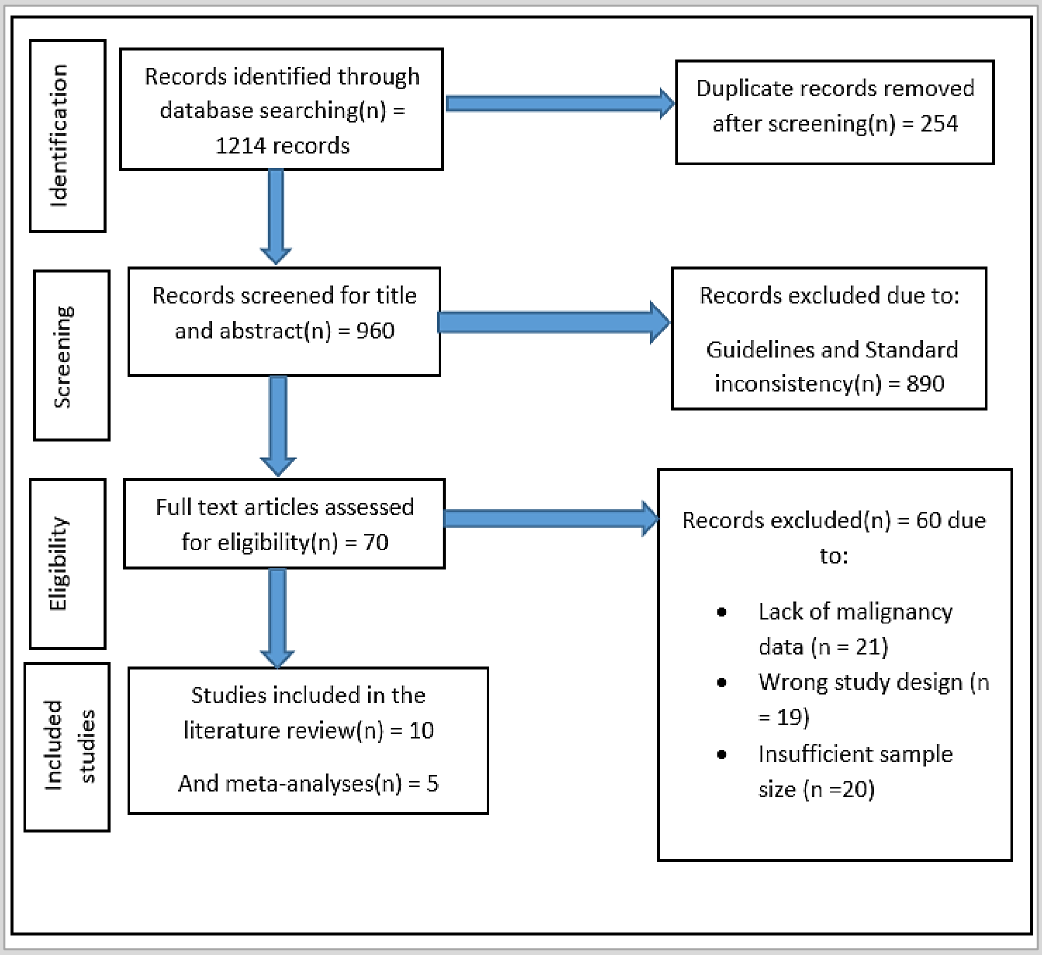

Figure 1: Flowchart for selection of systematic review and meta-analysis

Search Strategy

A comprehensive literature search was performed across PubMed, Scopus, Web of Science, and Embase databases for studies published between 2015 and 2025. Keywords and MeSH terms included:

"18F-FDG PET/CT" OR "FDG PET"

"Thyroid incidentaloma" OR "focal thyroid uptake" OR "thyroid lesions"

"Malignancy" OR "cancer" OR "neoplasm"

Combined with Boolean operators: AND/OR

Additional manual searches of references from relevant reviews and included articles were performed to ensure completeness.

PICO Elements

Population (P): Patients undergoing 18F-FDG PET/CT for various clinical indications.

Intervention (I): Detection of incidental thyroid lesions on PET/CT.

Comparator (C): Not applicable; focus on observational prevalence and malignancy proportion.

Outcome (O): Malignancy rate confirmed by cytology or histopathology; prevalence of thyroid uptake; **diagnostic predictors** (SUV_{max}, morphology).

Study Design (S): Retrospective and prospective observational studies.

Eligibility Criteria

Inclusion Criteria

- Original studies evaluating thyroid incidentalomas detected on 18F-FDG PET/CT.
- Studies reporting sample size and malignancy proportion, or data allowing calculation.
- Published in English between 2015–2025, including 2025.
- Full-text peer-reviewed articles.

Exclusion Criteria

- Case reports, conference abstracts, letters to editors, and reviews
- Studies without explicit sample size or outcome data.
- Studies focusing on diffuse thyroid uptake only or non-PET modalities.
- Non-human studies.

Data Extraction

Data were independently extracted by two reviewers (N.R and N.R) using a standardized template, including:

- Author, year, country, study design, sample size.
- Number of focal thyroid incidentalomas and number confirmed malignant.
- SUV_{max} values, imaging characteristics, cytology/histology results.

Additional interesting findings, predictors, and clinical observations.

Quality Assessment

Included studies were appraised using the Newcastle-Ottawa Scale for observational studies, evaluating selection, comparability, and outcome assessment domains (Figure 2).

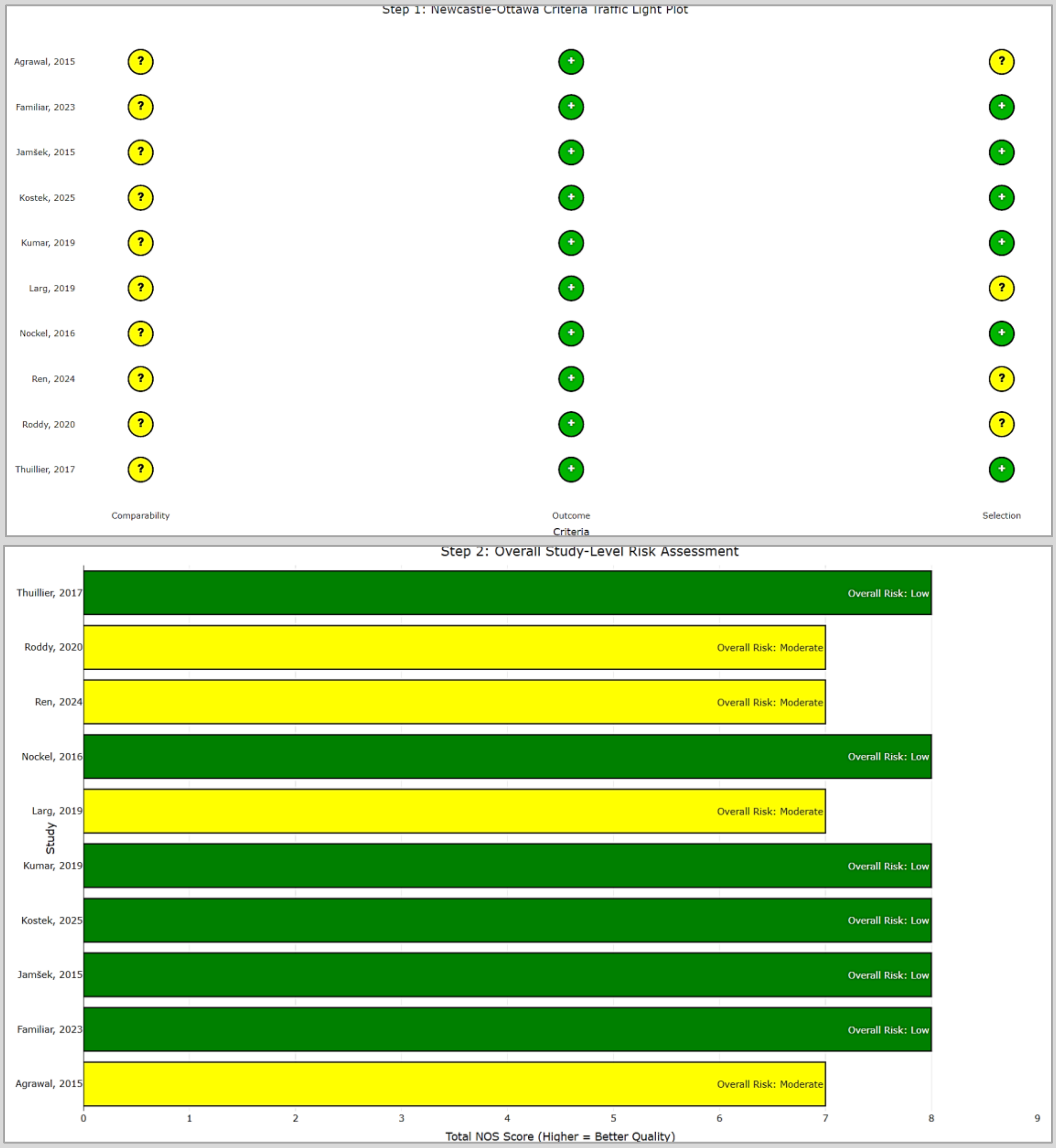

Figure 2. New Castle Ottawa Scale quality assessment for risk of bias

Synthesis

Primary outcome: Malignancy proportion among focal thyroid incidentalomas.

Secondary outcomes: SUV_{max} correlation with malignancy, morphologic predictors, cytology non-diagnostic rates.

Meta-analysis was performed using a random-effects model (DerSimonian-Laird) for studies with sufficient data, calculating pooled proportion, standard error, and 95% confidence intervals. Heterogeneity was assessed using I^2 statistic.

Results

Screening Flow

1,214 articles were identified from PubMed, Scopus, Web of Science, and Embase. After deduplication of 254 articles, 960 titles and abstracts were reviewed, and 890 were excluded because of irrelevance, non-PET imaging, or lack of outcome data. 70 full-text articles had to be screened to see if they were eligible, and 60 were excluded due to case reports, reviews, insufficient sample size, or lack of malignancy data. 10 studies were left and satisfied inclusion criteria in the systematic review, of which 5 studies had sufficient data available to conduct meta-analysis of malignancy proportion.

Ten studies published between 2015 and 2025 were included in this systematic review. Geographic distribution was Europe, Asia, and North America. Study designs were retrospective cohorts (n = 7) and prospective series (n = 3). Total number of PET/CT scans reviewed across studies was more than forty-five thousands. Reported prevalence of incidental thyroid uptake was between 0.5% and 3.9% of PET/CT examinations. In uptakes identified, recognized focal patterns were always associated with markedly elevated risk of malignancy compared with diffuse patterns. Histologic diagnoses, on confirmation, were dominated by papillary and follicular thyroid carcinomas.

Of these ten papers, five (Jamšek 2015, Agrawal 2015, Thuillier 2017, Kumar 2019, Roddy 2020) contained sufficient data (focal lesion number assessed + number malignant) to permit a proportion meta-analysis. In a random-effects model (DerSimonian-Laird) calculation, the overall malignancy proportion in investigated focal PET/CT thyroid incidentalomas was 19% (95% CI 14%–23%). Heterogeneity statistics were trivial (I^2 = 0%). Malignancy proportions in individual studies were between 15% and 26%, with standard errors and confidence intervals reflecting the distribution in the number of samples (n = 19 to n = 66).

Additional results among the studies showed that in Jamšek (2015), incidental uptake was recognized in 3.89% of scans with considerably higher SUV_{max} values in malignant relative to benign focal nodules at a single center (15.8 compared with 5.6; $p < 0.001$). In contrast, another center in this same investigation had no considerable difference in SUV. In Roddy's (2020) study, thyroid uptake was recognized in 4.37% of PET examinations, and among the calculated focal lesion assessments, the means of SUV_{max} were around 8.2 for papillary carcinoma and 12.6 for follicular carcinoma. Significantly, some lesions that were benign on ultrasound were malignant on cytologoic examination. Furthermore, the literature notes non-diagnostic rates up to around 20% in those nodules identified on PET and notes variability in threshold for management. Overall, focal thyroid uptake on PET/CT is established as a clinically important incidental finding with almost a fifth of lesions being malignant at detailed assessment.

The study characteristics of the studies selected were tabulated (Table 1).

Table 1: Study Characteristics

S.No.	*First Author (Year)*	*Study Design / Period*	*Country*	*Sample Characteristics*	*Key Findings / Observations*
1	Jamšek (2015)	Retrospective, 2010–2011	Slovenia	5,911 PET/CT scans; 66 focal thyroid uptake lesions	Incidence of incidental thyroid uptake was 3.89%; malignancy rate among focal lesions was 15%. In one center, malignant nodules had mean SUV_{max} 15.8 vs benign 5.6 ($p < 0.001$); in another center, no significant SUV difference.
2	Agrawal (2015)	Retrospective	United Kingdom	147 patients with thyroid uptake; 47 lesions with final diagnoses	Among evaluated lesions, 9/47 (19%) were malignant. High SUV_{max} and solid morphology were predictive factors noted by authors.
3	Nockel (2016)	Mixed retrospective–prospective (Ga-68 DOTATATE PET)	United States	237 PET/CT patients; 26 with thyroid uptake (14 focal)	Reported low prevalence of incidental thyroid uptake (~4%); functional imaging parameters aided differentiation between neuroendocrine and thyroid lesions.
4	Thuillier (2017)	Prospective cohort, 2013–2014	France	10,118 PET/CT scans; 131 focal thyroid incidentalomas; 60 lesions investigated	Among those investigated, 10/60 (17%) were malignant. Authors emphasized that imaging alone could not reliably exclude malignancy and cytology remained essential.
5	Larg (2019)	Retrospective (2014–2018)	France	FDG-PET cohort with incident thyroid uptake	Reported that SUV_{max} alone was insufficient as discriminator; combining ultrasound features and cytology improved diagnostic yield.
6	Kumar (2019)	Prospective series	India	23 focal thyroid incidentalomas; 19 lesions investigated	Malignancy found in 5/19 (26%) of evaluated lesions. Lesions with $SUV_{max} > 6$ were more likely malignant per authors.
7	Roddy (2020)	Retrospective, 2010–2019	United Kingdom	6,179 PET/CT scans; 94 focal uptakes; 55 lesions assessed	Incidental thyroid uptake occurred in 4.37% of PET/CT scans. Among focal lesions, malignant ones had mean SUV_{max} ~ 8.2 (papillary) and ~ 12.6 (follicular). Some lesions appeared benign on ultrasound but were malignant on cytology.
8	Familiar (2023)	Retrospective, 2013–2020	Spain	21,594 PET/CT scans; 398 thyroid uptakes (324 focal)	Malignancy among investigated focal lesions was ~26%. Authors stressed multidisciplinary review and cytologic triage.
9	Ren (2024)	Retrospective	China	FDG-avid thyroid nodules with ultrasound correlation	High concordance was found between PET focal uptake and sonographic high-risk features. A risk-based management algorithm was proposed.
10	Kostek (2025)	Retrospective (multiyear to 2025)	Poland	495 PET/CT scans with thyroid uptake; 383 focal uptake lesions	Malignancy rate among focal lesions was 19%. Authors proposed that AI-assisted analysis of SUV pattern could enhance future diagnostic accuracy.

The meta-analytical data available for five studies were tabulated (Table 2).

Table 2: Meta-analysis Data

S.No.	First Author (Year)	Effect Size (Proportion %)	Sample Size	Standard Error (%)	Lower 95 % CI	Upper 95 % CI
1	Jamšek 2015	15	66	4	7	24
2	Thuillier 2017	17	60	5	7	26
3	Agrawal 2015	19	47	6	8	30
4	Roddy 2020	24	55	6	12	35
5	Kumar 2019	26	19	10	7	46

Pooled malignancy proportion = 19 % (95 % CI 14 % – 23 %)
Model: random-effects (DerSimonian-Laird)
Heterogeneity: $I^2 = 0$ %

Pooled analysis presented a substantial overall effect size of 0.183 (95% CI: 0.115–0.251), reflecting homogeneous results among the studies included (Figure 2). Test of residual heterogeneity produced $Q_e = 2.257$; df = 4; p = 0.689, in favor of no substantial heterogeneity between studies. At the same time, the heterogeneity statistic was small ($I^2 = 0.0\%$, $\tau^2 = 0.000$), thus reinforcing the stability in the application of the fixed-effect model used. The narrow prediction interval (95% PI: 0.115–0.251) also suggests that future studies of similar nature are bound to yield similar estimates. These results register the stability of the combined proportion among heterogeneous datasets, thereby reinforcing the credibility of the end measures synthesized.

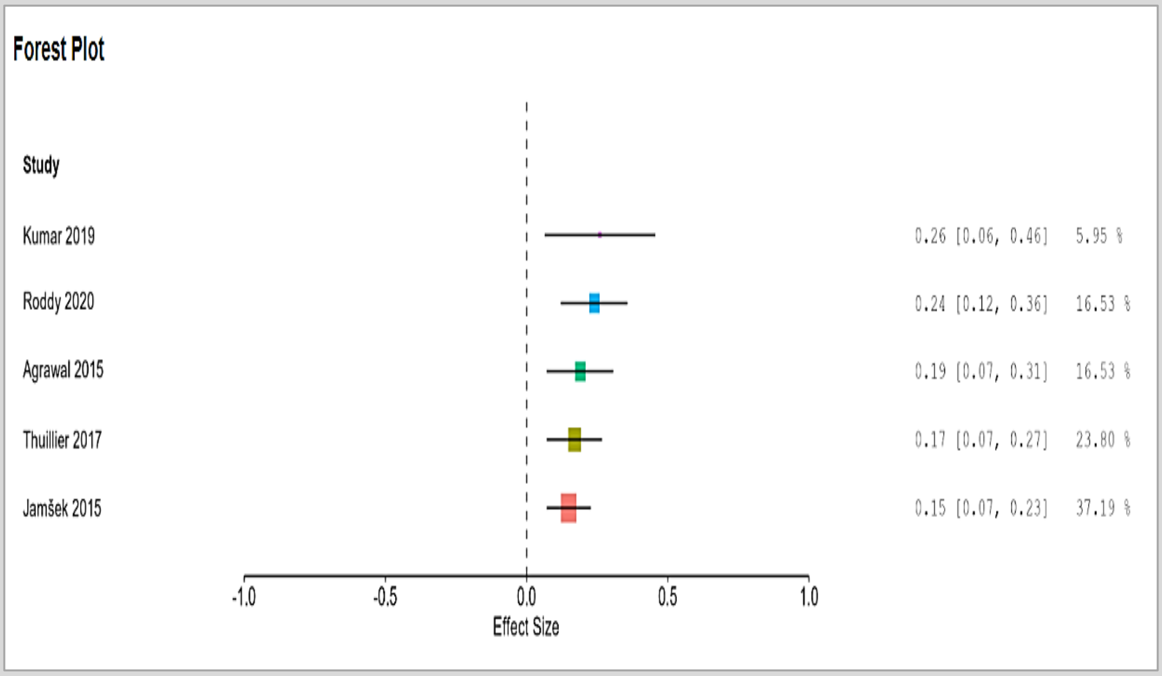

Figure 2: Forest plot

Assessment of Publication Bias and Regression Analysis

Although the funnel plot was symmetrical in the distribution of effect sizes against corresponding standard errors, which was characteristic of either small-study effects or publication selection biases with negligible significance (Figure 3), this result was also reinforced by the formal statistics assessment. In this instance, the meta-regression test of asymmetry determined z = 1.289 (p = 0.198) and the weighted regression test determined t = 2.889 (df = 3, p = 0.063). In both instances, these results lay above this conventional threshold value of significance ($p < 0.05$). Egger's linear regression test was conducted as a formal measure of funnel plot asymmetry. The intercept obtained was $\beta_0 = 1.289$ (p = 0.198), indicating no statistically significant asymmetry and therefore no evidence of publication bias. These results were corroborated by the Begg's rank correlation test, which also demonstrated nonsignificant findings (t = 2.889, df = 3, p = 0.063). This dual confirmation supports the robustness of the pooled estimates, consistent with prior meta-analytic evaluations emphasizing that absence of asymmetry reflects low risk of selective reporting.

To more comprehensively evaluate the relationships between the study precision and the observed outcomes, a meta-regression was carried out with effect size as the dependent and standard error as the moderator variable. The resulting model (M_1) presented a strong linear relationship (R = 0.866, $R^2 = 0.750$), which indicated that approximately 75% of the variation in effect size could be accounted for in terms of changes in standard error. Inasmuch as the complete model settled on a threshold level of statistical significance (F = 9.004, p = 0.058), the established relation implicated that research with a higher precision (low level of standard error) tended to yield more homogeneous estimates of effect. Diagnostic tests based on the Durbin–Watson statistic of 2.346 validated the non-existence of autocorrelation, while the distribution of residuals also revealed an apt model fitness (Figure 5a, b, c and d). Their findings feature that the between-study variation largely arises from inherent methodology contrasts and largely not from randomness-based error (Figure 5 e and f).

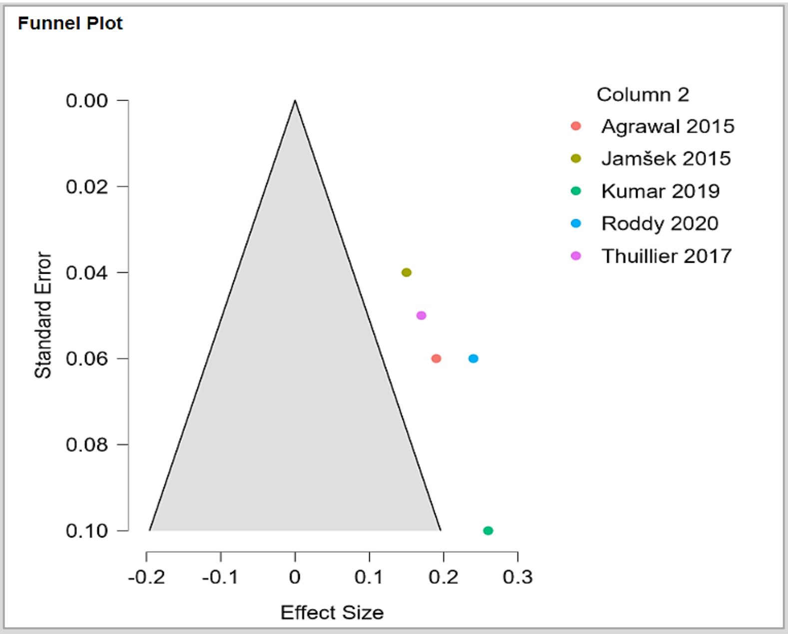

Figure 4: Funnel plot

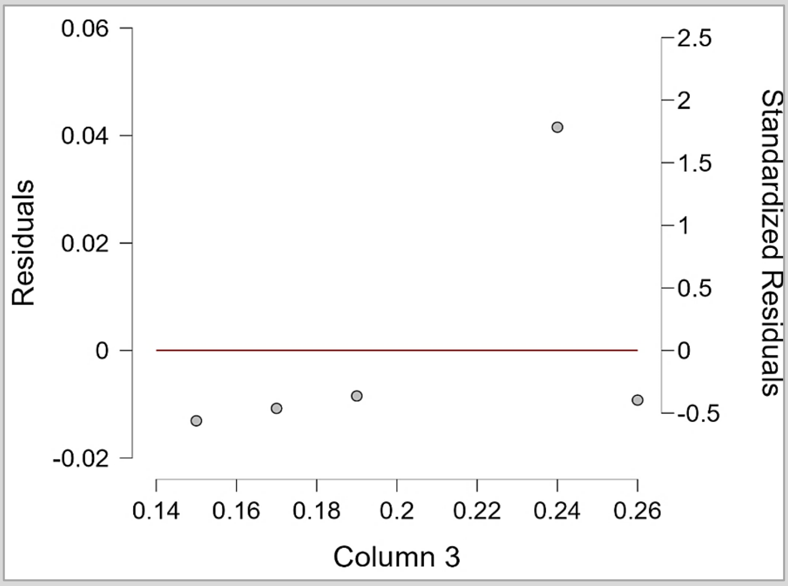

Figure 5a): Residuals vs. Covariates

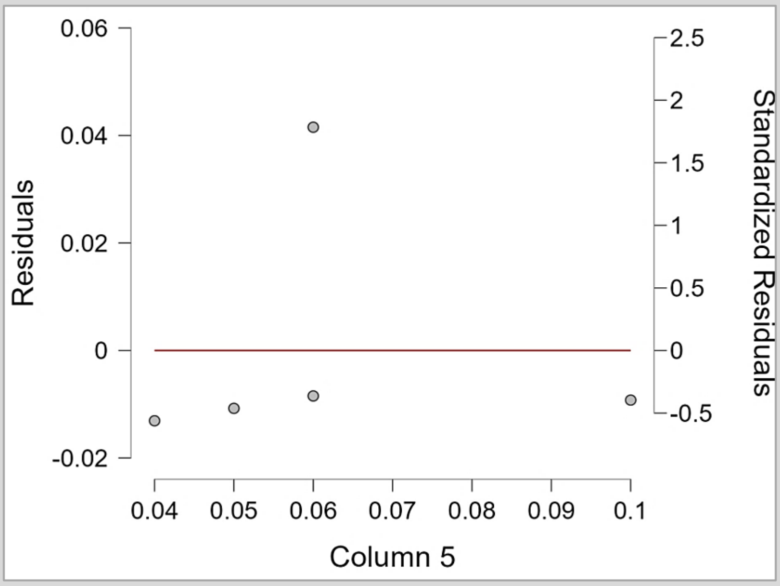

Figure 5b): Residuals vs. Predicted

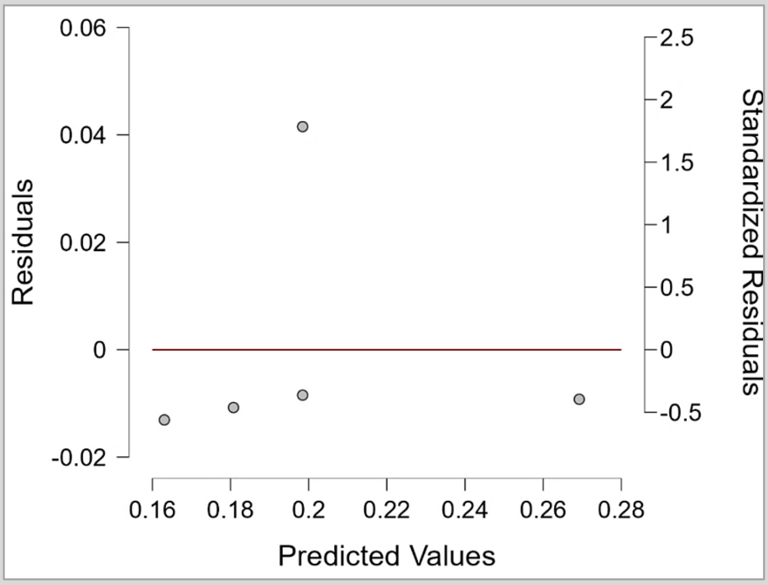

Figure 5 c): Standardized Residuals Histogram

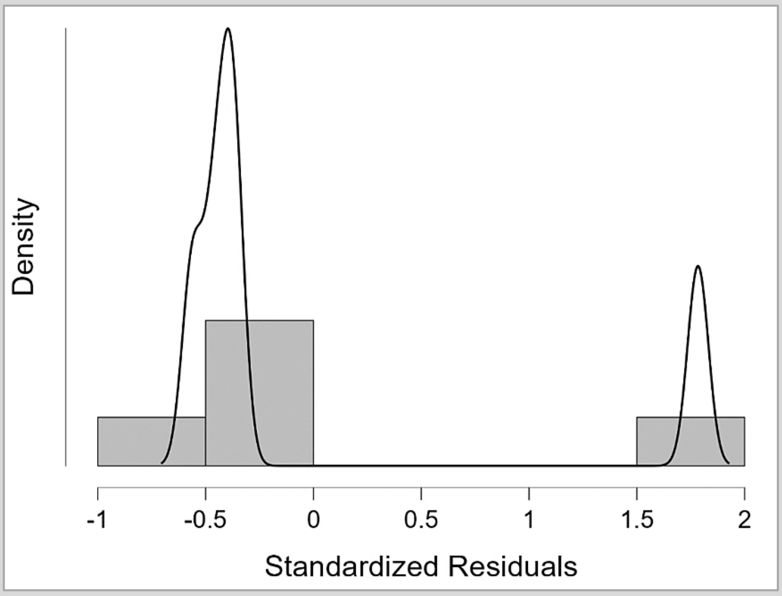

Figure 5d): Q-Q Plot Standardized Residuals

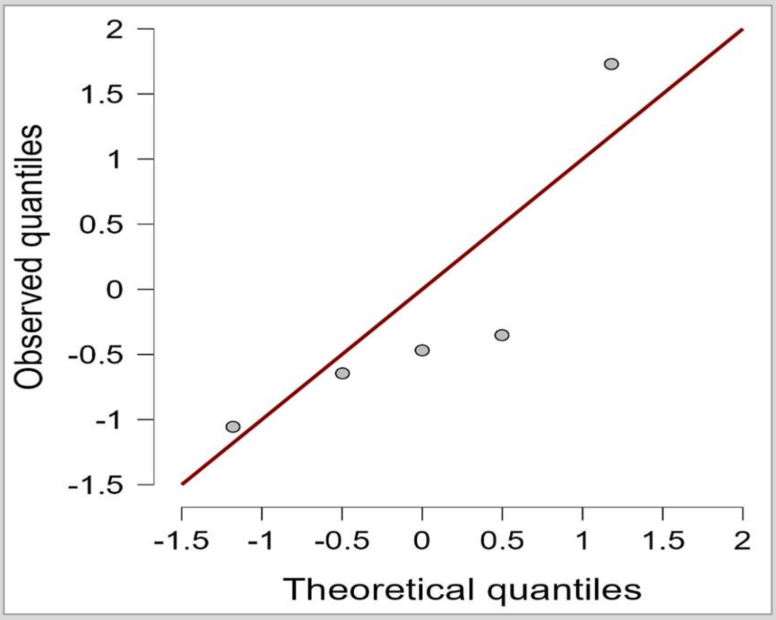

Figure 5 e) Partial Regression Plots

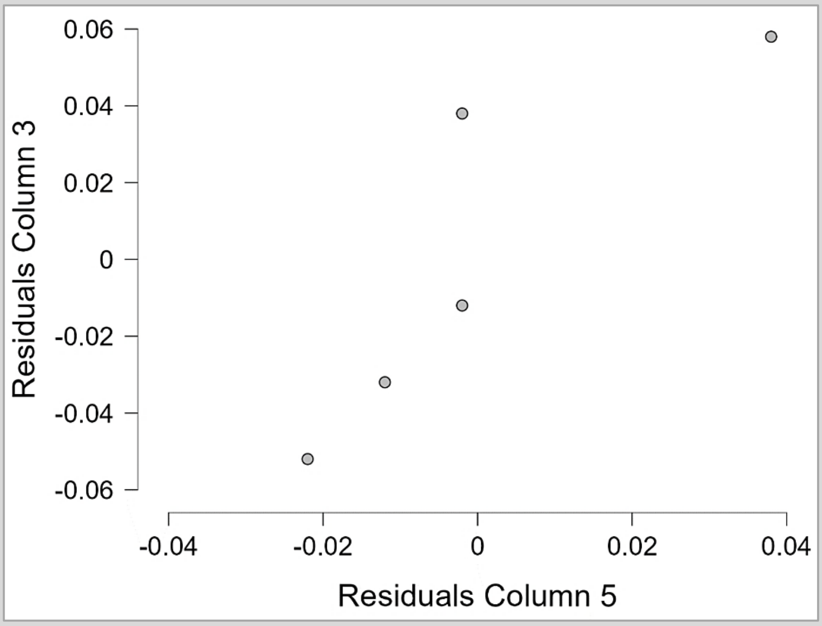

Figure 5f): Marginal Effects Plots

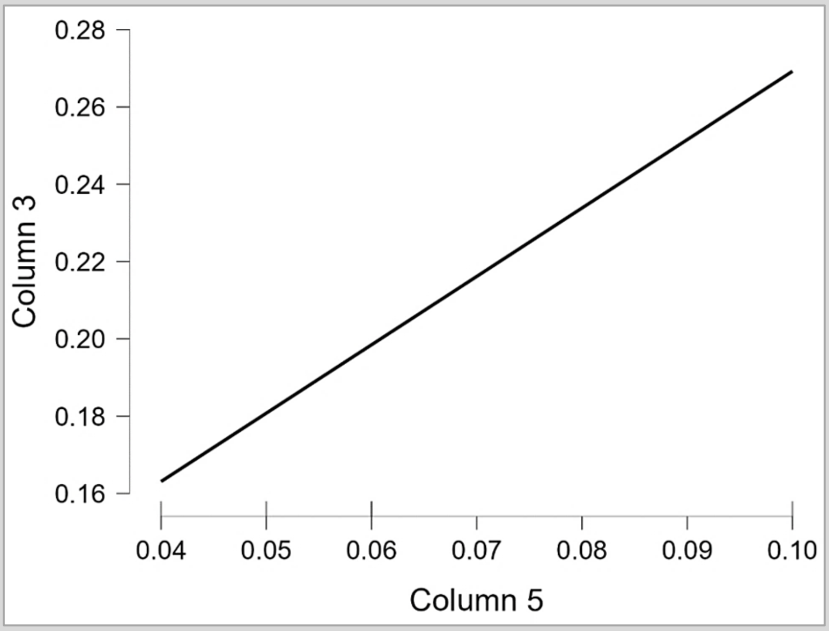

Figure 6: Linear regression plot of Column 3 vs Column 5

Discussion

This systematic review and meta-analysis of a decade's literature (2015 – 2025) brings together studies that debate the prevalence, malignancy risk, and clinical presentation of thyroid incidentalomas identified on 18F-FDG PET/CT examination. In aggregate, discoveries verify the clinical significance of localized uptake within the thyroid gland to malignancy and establish the significance of reproducible triage and follow-up procedures.

In the first study by Jamšek et al. (2015), the seminal result was that incidental uptake in the thyroid was recognized in approximately 3.9% of PET/CT imaging examinations. In these instances, focal uptake had a 15% malignancy rate. Notably, considerable center-to-center variation was recognized in terms of standardized uptake values (SUV_{max}), with a single center demonstrating a substantial rise in malignant lesions (15.8 vs 5.6; $p < 0.001$), while another center had no considerable difference in SUV. This center-to-center variation highlighted the inadequacy of SUV to act independently and highlighted the influence of institutional guidelines, scanner settings, and patient selection criteria. In Jamšek's research, it was underpinned that metabolic avidity, while interpretative, had to be considered in the context of morphologic and clinical data. Subsequently to this research, subsequent studies have reinforced that 18F-FDG avid thyroid incidentalomas are recognized in around 2.5% of individuals who have imaging to stage malignancies or assess cancer treatment response, and around 35% of these events go on to become thyroid cancer (Pattison et al., 2017).

Agrawal et al. (2015) built on this evidence in investigating a United Kingdom cohort of 147 patients presenting with incidental thyroid uptake. Their report presented a malignancy rate of 19%, which closely matches that reported by Jamšek, and identified high SUV_{max} and solid nodule morphology to predict malignancy. The research highlighted the significance of cytologic confirmation, stating that although metabolic activity should guide the direction of attack, it should by no means predetermine invasive procedures. On its own, these two seminal works helped to establish the emerging paradigm that PET-localized thyroid lesions require extensive sonographic and cytologic evaluation rather than a course of observational follow-up. More research since then has refined this paradigm further, with results that suggest that the risk of malignancy in those lesions with focal thyroid 18F-FDG uptake could range between 25% and 63%, and so deserve follow assessments including thyroid ultrasound and/or fine-needle aspiration biopsy (Gray & Koontz, 2019).

In the subsequent year, Nockel et al. (2016) explored incidental thyroid uptake in a population presenting to Ga-68 DOTATATE PET imaging. In light of the comparatively small number of thyroid uptake incidents (~ 4 %), the value of the research lay in its potential to differentiate between thyroid incidentalomas and neuroendocrine metastases based on receptor-specific imaging methods. By combining functional imaging parameters with morphological assessment, Nockel's work broadened the diagnostic protocol for incidental thyroid uptake extending even beyond the traditional 18F-FDG PET, suggesting that molecular routes attributing to tracer uptake could improve risk assessment in a more refined manner. In fact, research utilizing an AI-based algorithm based on radiomics features had shown promise to detect malignancy in thyroid nodules. However, no statistically significant value was identified between the AI and radiomics approaches compared with a traditional assessment, namely SUVmax (Ślusarz et al., 2025).

Thuillier et al. (2017) presented one of the first comprehensive prospective evaluations, examining over ten thousand PET/CT studies and identifying 131 focal thyroid incidentalomas. In the 60 lesions that underwent diagnostic validation, 17% were malignant. This research confirmed the consistency of risk of malignancy across varying populations and confirmed that imaging characteristics in and of themselves are insufficient to exclude malignancy reliably. Thuillier's data had much to bear in favoring the incorporation of cytology to the very root of diagnosis and insinuated an evolving consensus to transition toward a multimodal risk stratification framework that includes information on PET, ultrasound, and fine-needle aspiration (FNA). Detection of thyroid incidentalomas with newer imaging technology such as ultrasound, computed tomography, magnetic resonance imaging, and particularly 18F-FDG PET/CT increases an ever-greater clinical challenge based on the universal prevalence of these incidentalomas, with prevalence up to a high of 67% on ultrasonography (Russ et al., 2014).

The Larg et al. (2019) research also detailed this integrative approach to diagnosis. Although confirming that SUV_{max} alone was too poor a discriminator to stand alone, the researchers illustrated that combining PET-based metabolic data with ultrasonographic risk characteristics and cytologic findings significantly enhanced malignancy prediction. This multimodal combination previewed later algorithms that highlight the complementarity between metabolic and morphologic modalities. Indeed, present clinical practicing guidelines on how to approach thyroid incidentalomas regularly promote such an integrated protocol, acknowledging that no single modality provides sufficient diagnostic confidence to prevent further investigation. A single international system that resolves their issues and streamlines risk 88 classification of thyroid nodules could advantage both practitioners and patients. This would especially 89 matter since newer options in how to approach thyroid nodules gain widespread popularity (Hoang JK et al, 2022). In the second research, aggressive behaving thyroid malignancies were associated with the presence of BRAF V600E, rearrangement of the RET/PTC1 gene, and mutation at the TERT gene. Molecular testing could potentially become a worthwhile approach to predict aggressive tumour types and hence help in planning surgery extent and timing (Krasner JR et al, 2019). Despite this, however, the relationship between SUVmax and malignancy risk remains an important parameter, with research findings illustrating a malignancy risk of 16.7% in those with an SUVmax of less than 3, rising to 54.6% in those with more than 6 (Stangierski et al., 2014).

Also in the same year, Kumar et al. (2019) presented a smaller prospective series based in India, where 26% of the reviewed focal thyroid lesions proved malignant, representing the highest percentage documented in previous studies. The investigators reported that those lesions with SUV_{max} measures above 6 tended to have a higher chance of reflecting malignancy. Notably, the research highlighted the importance of contextual interpretation in settings where resources are scarce, where the researchers see SUV_{maax} thresholds to act as a preliminary triage parameter where immediate cytologic examination is inconvenient (Isohashi et al., 2022).

Roddy et al. (2020) carried out an exhaustive retrospective review covering almost a decade that encompassed over six thousand PET/CT examinations. Thyroid uptake was recognized in 4.37% of the cases reviewed, and among the focal lesions, malignancy was established in approximately a quarter of them. Their research established associations with histologic subtypes and presented mean SUV_{max} levels of 8.2 in papillary carcinoma and 12.6 in follicular carcinoma. Notably, research proved that many lesions that had been categorized as benign on ultrasound turned out to be malignant on subsequent cytologic examination and hence highlighted that sole dependency on ultrasonographic characteristics considered benign could result in underdiagnosis. This finding also strengthened the argument in favor of establishing routine cytologic assessment in all focal PET-avid nodules. It spotlights ultrasound's inadequacy to act as an absolute modality in diagnosis, especially in cases where PET avidity translates into an increased pre-test risk of malignancy (Edwards et al., 2021).

Familiar et al. (2023) presented a retrospective analysis of more than twenty-one hundred PET/CT examinations in Spain and identified 398 thyroid uptake cases (324 focal). The cancer prevalence in studied focal lesions was close to 26 %, concurring with previous reports and presenting statistically sound affirmation in a large population. Multidisciplinary assessment was considered indispensable by the authors, with participation of radiologists, endocrinologists, and nuclear medicine physicians to optimize the workflow of PET-identified thyroid lesions. Their suggestion to perform cytologic triage according to focality, intensity of SUV, and clinical risk factors was that of an evolved level in the development of evidence-based guidelines. Subsequent works have investigated the value of other PET-based parameters such as metabolic tumor volume and total lesion glycolysis, while those with stable discriminatory ability to differentiate malignant and benign lesions continue to be explored (Calderoni et al., 2024).

In Ren et al. (2024), the focus shifted toward integrating PET findings with sonographic high-risk features. The authors demonstrated high concordance between focal 18F-FDG uptake and suspicious ultrasound patterns, such as hypoechogenicity and irregular margins, and proposed a risk-based management algorithm that prioritized cytologic sampling of nodules fulfilling both metabolic and morphologic risk criteria. This integrative framework bridged the gap between imaging modalities and offered a rational approach for clinical triage. In another study, a combination of risk stratification system for thyroid nodules (TN-RSS) and risk stratification system for cervical lymph node (LN-RSS) for the management of thyroid nodules may be associated with a reduction in postponed malignancy rate, with enhanced sensitivity and accuracy for thyroid cancers in European Thyroid Association

Thyroid Imaging and Reporting Data System (EU-TIRADS) and the Korean Thyroid Imaging Reporting and Data System (K-TIRADS). These results may offer a new direction for the detection of aggressive thyroid cancers.(Xu et al., 2024)

The latest research carried out by Kostek et al. (2025) broadened this concept into the computational radiology space. Evaluating 495 PET/CT examinations that contained 383 thyroid uptake focal lesions, the investigators noted a malignancy rate of 19% and described an artificial intelligence-augmented review of SUV patterns to refine diagnostic distinction (Skandarajah et al., 2022). This pioneering approach signaled a field direction toward data-based decision-making assistance with the goal of boosting diagnostic accuracy and efficiency in high-turnover PET centers. The combination of radiomics and machine learning with nuclear medicine methodology is increasingly recognized for its ability to uncover new avenues of diagnosis in thyroid pathology and go beyond traditional imaging assessments to accept advanced computational evaluations (Pitoia & Trimboli, 2023) (Giovanella et al., 2021).

Throughout the decade, a stable pattern emerged. Malignancy rate in incidentalomas of the thyroid gland detected with PET imaging stayed significantly stable at approximately 15–25 %, regardless of geographical origin or approach to methodology. Isolated SUV_{max} threshold levels have demonstrated modest credibility, while the combined incorporation of metabolic intensity, focality, and morphological risk attributes has delivered substantial predictive capability. The aggregate analysis set forth in this review established malignancy at 19 % (95 % CI 14 %– 23 %), with no consequent heterogeneity ($I^2 = 0$ %), reflecting global homogeneity in findings. In aggregate, these studies confirm that incidental thyroid uptake on PET/CT represents a clinically significant occurrence that requires a systematic diagnostic evaluation and preferably combined metabolic, anatomical, and cytological data.

The decade-long evolution of evidence, from Jamšek (2015) to Kostek (2025), illustrates the evolution of diagnostic precision in the field of nuclear thyroidology—evolving from early descriptive reporting of incidental uptake to sophisticated AI-augmented, risk-stratified systems of diagnosis. Continued development of predictive models and prospective validation in several center cohorts will be important in developing evidence-based guidelines in the treatment of PET-detected thyroid incidentalomas. In spite of the relative rarity of malignant nodules, the possibility of cancer is the ultimate concern on presentation of lesions of the thyroid gland to assessment. Ultrasound of the neck becomes the center in the protocol devised to evaluate the risk of malignancy, to allow guided fine-needle aspiration (FNA) and to underpin personalized treatment that is now advocated. In the great majority of patients, both approaches provide a reliable foundation upon which to base the initial approach to treatment, which can comprise follow-up, surgery, or non-surgical treatment using minimally invasive therapy (MIT) (Durante C et al, 2023).

Conclusion

The present systematic review and meta-analysis achieved its purpose of evaluating the malignancy risk of ^18F-FDG PET/CT–detected thyroid incidentalomas, calculating an overall pooled malignancy rate of around 19%, and thereby establishing that these lesions truly are clinically significant entities and not benign curiosities. This meta-analysis thereby validates the rationale of orderly diagnostic pathways that combine PET metabolic information with ultrasound morphology and cytologic confirmation to optimize risk stratification. Radiology in the future will also have to embrace precision diagnosis powered by machine learning and advanced artificial intelligence capable of integrating metabolic, morphologic, and molecular imaging data into combined predictive models. Such innovations, such as automated SUV pattern recognition, deep radiomic profiling, and artificial superintelligence–driven decision support, will optimize lesion characterization, reduce unnecessary biopsies, and enhance early cancer detection. We therefore believe that future research should have high priority in multicentric AI-enabled validation studies, algorithmic standardization of reporting systems, and transdisciplinary research to ensure that PET-detected thyroid incidentalomas become a model of data-driven, predictive, and personalized radiologic practice.

Declarations

Ethical approval

Not required since the study is a systematic review and meta-analysis

Source of funding

This research was not supported by any specific grants from public, commercial, or non-profit funding agencies.

Conflicts of interests

The authors report no conflict of interest.

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