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DIAGNOSTIC ACCURACY OF NASAL CYTOLOGY IN DIFFERENTIATING ALLERGIC AND NON-ALLERGIC RHINITIS: A SYSTEMATIC REVIEW

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ABSTRAK

Rinitis alergi dan rinitis non-alergi memiliki gejala klinis serupa, tetapi memerlukan pendekatan terapeutik yang berbeda. Diagnosis yang akurat sering bergantung pada *Skin Prick Test* atau IgE spesifik yang tidak selalu tersedia. Sitologi hidung merupakan metode sederhana dan non-invasif yang berpotensi menjadi alat diagnostik alternatif. Tinjauan ini bertujuan mengevaluasi akurasi diagnostik sitologi hidung dalam membedakan kedua kondisi tersebut serta potensi hubungan antara eosinofil nasal smear dan derajat keparahan gejala rinitis alergi**.** Tinjauan sistematis dilakukan sesuai PRISMA 2020. Pencarian literatur dilakukan di PubMed dan Google Scholar untuk periode 2020–2025. Kriteria inklusi berdasarkan PICOSTD mencakup studi diagnostik dan observasional pada pasien dengan gejala rinitis, menggunakan sitologi hidung sebagai tes indeks dan metode standar sebagai pembanding. Kualitas studi dinilai menggunakan JBI Critical Appraisal Tools dan data dianalisis secara kualitatif. Sebanyak empat studi memenuhi kriteria inklusi. Sitologi hidung menunjukkan sensitivitas 76,66%–100% dan spesifisitas 49,6%–87,77%. Eosinofilia secara konsisten berkaitan dengan rinitis alergi, sedangkan pola neutrofilik lebih dominan pada rinitis non-alergi. Namun, kekuatan hubungan antara kadar eosinofil nasal smear dan derajat keparahan gejala belum dapat ditentukan secara kuantitatif karena koefisien korelasi dan ukuran keparahan yang sebanding tidak dilaporkan secara konsisten. Heterogenitas metode pemeriksaan, standar diagnostik, dan faktor pengganggu berkontribusi terhadap variasi akurasi diagnostik. Sitologi hidung merupakan metode sederhana, hemat biaya, dan semi-invasif yang lebih tepat digunakan sebagai pemeriksaan pendukung atau skrining, bukan sebagai pengganti tunggal SPT.
Kata Kunci: *Sitologi Hidung, Rinitis Alergi, Rinitis Non-Alergi, Akurasi diagnostik*

ABSTRACT

Allergic Rhinitis and Non-Allergic Rhinitis have similar clinical symptoms but require different therapeutic approaches. Accurate diagnosis often relies on the Skin Prick Test or specific IgE, which are not always available. Nasal cytology is a simple, non-invasive method with potential as an alternative diagnostic tool. This review aimed to evaluate the diagnostic accuracy of nasal cytology in distinguishing these conditions and the potential relationship between nasal smear eosinophils and allergic rhinitis symptom severity. A systematic review was conducted according to PRISMA 2020. Literature searches were conducted in PubMed and Google Scholar for 2020–2025. Inclusion criteria based on PICOSTD included diagnostic and observational studies involving patients with rhinitis symptoms, using nasal cytology as the index test and standard methods as comparators. Study quality was assessed using the JBI Critical Appraisal Tools, and data were analyzed qualitatively. Four studies met the inclusion criteria. Nasal cytology showed sensitivity ranging from 76.66% to 100% and specificity from

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49.6% to 87.77%. Eosinophilia was consistently associated with allergic rhinitis, whereas neutrophilic patterns were more dominant in non-allergic rhinitis. However, the strength of the relationship between nasal smear eosinophil levels and symptom severity could not be quantitatively determined because correlation coefficients and comparable severity measures were not consistently reported. Heterogeneity in examination methods, diagnostic standards, and confounding factors contributed to variations in diagnostic accuracy. Nasal cytology is a simple, cost-effective, and semi-invasive tool that is best used as an adjunctive or screening method rather than a standalone replacement for SPT.
Keywords: *Nasal Cytology, Allergic Rhinitis, Non-Allergic Rhinitis, Diagnostic Accuracy*

INTRODUCTION

Rhinitis is a highly prevalent inflammatory condition of the nasal mucosa and one of the most widespread chronic diseases worldwide, affecting all age groups with an estimated global prevalence ranging from 10% to 54% (Annesi-Maesano et al., 2002; Wise et al., 2018). This condition is generally classified into Allergic Rhinitis and Non-Allergic Rhinitis. Clinically, AR is characterized by type-1 immunoglobulin E (IgE)-mediated inflammation of the nasal mucosa in response to allergen exposure, manifesting in symptoms such as rhinorrhea, sneezing, nasal obstruction, and itching (Bousquet et al., 2001). Given its significant impact on reduced quality of life and work productivity, standardization of diagnosis is crucial in clinical practice (Wise et al., 2018). The diagnostic evaluation of rhinitis may involve clinical assessment, allergy testing, and nasal cytology, depending on the underlying phenotype and the availability of diagnostic resources (Testera-Montes et al., 2021).

Etymologically, the term 'Allergy' originates from the German word 'Allergie,' coined in 1906 by Clemens von Pirquet and Bela Schick, combining the Greek roots allos (other/different) and ergon (activity). In the historical development of its diagnosis, a strong correlation between nasal eosinophil counts and allergic rhinitis was first conclusively documented by Eyermann in 1927. Since then, various studies have continued to evaluate the role of eosinophils in mucosal inflammation, where tissue infiltration by these inflammatory cells has become a hallmark of the late-phase allergic reaction. Although the Skin Prick Test (SPT) is still recognized as the gold standard alongside serum IgE measurement, ELISA, and RAST, these methods face significant challenges in clinical implementation in many regions. These tests often require high costs and are only available at tertiary healthcare centers or certain private laboratories (Wise et al., 2018; Brożek et al., 2017). For example, in healthcare settings such as in Yaoundé, Cameroon, SPT is not available in public hospitals and is considered unaffordable for the majority of the population.

In this context, nasal cytology, which has been proposed since the 1930s and further developed in the 1980s, has emerged as an important diagnostic alternative (Ciofalo et al., 2022). This method evaluates the normal and pathological aspects of the nasal mucosa by identifying and counting cell types and their morphology through a light microscope. Nasal cytology offers a simple, economical, semi-invasive procedure that is safe for use at any age without the risk of anaphylactic reactions. Furthermore, cytology allows clinicians to differentiate various rhinitis phenotypes based on their cellular patterns, such as allergic rhinitis dominated by eosinophils and mast cells, to variants of non-allergic rhinitis (NAR) such as non-allergic rhinitis with eosinophilia (NARES), non-allergic rhinitis with mast cells (NARMA), and non-allergic rhinitis with neutrophils (NARNE) (Gelardi et al., 2011; Fokkens et al., 2020). This cellular approach is particularly relevant because rhinitis is increasingly understood as a

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heterogeneous condition involving distinct inflammatory and immunological mechanisms rather than a single disease entity (Meng et al., 2021).

Despite these advantages, the clinical value of nasal smear eosinophil quantification remains insufficiently established, particularly regarding its ability to reflect the severity of allergic inflammation rather than merely distinguish allergic from non-allergic rhinitis. Previous studies have primarily evaluated nasal eosinophils as a diagnostic marker by comparing their presence or proportion with established reference tests such as SPT and serum-specific IgE, while evidence regarding the relationship between eosinophil levels and the severity of clinical manifestations remains inconsistent. This distinction is important because a diagnostic marker that can also indicate disease severity may provide additional clinical value, particularly in settings where SPT or serum IgE testing is difficult to access. Therefore, further evaluation is needed to determine whether nasal smear eosinophil quantification can provide clinically meaningful information beyond the diagnosis of allergic rhinitis and whether its performance is sufficiently reliable to support its use as a practical indicator of disease severity.

Despite its utility, the diagnostic performance of nasal cytology remains a subject of intense debate due to inconsistent findings across different studies. For instance, while some research in India reports high accuracy (82.27%) and sensitivity (76.64%), other studies, such as those conducted in Cameroon, label the tool as "mediocre" with poor sensitivity (37.5%) (Atanga et al., 2023; Chaudhary et al., 2024). These divergent findings indicate that the usefulness of nasal smear eosinophil assessment may vary according to population, reference standard, staining technique, and the threshold used to define eosinophilia. Moreover, the existing evidence has not clearly established whether higher eosinophil counts consistently correspond to greater clinical severity, creating an important research gap between the diagnostic identification of allergic rhinitis and the assessment of disease severity. Furthermore, because the symptoms of AR, NAR, and chronic rhinosinusitis (CRS) are significantly overlapping, a diagnosis based solely on clinical history is often unfeasible. Recent evidence also emphasizes that distinguishing allergic, non-allergic, and local allergic rhinitis remains challenging because of overlapping clinical manifestations and limitations of conventional diagnostic approaches (Mortada & Kurowski, 2023). Consequently, a systematic evaluation of nasal smear eosinophil quantification is warranted to clarify its diagnostic performance and its potential value as an indicator of disease severity, particularly in resource-limited healthcare settings.

The primary objective of this systematic review is to evaluate the diagnostic accuracy of nasal cytology in differentiating between allergic and non-allergic rhinitis. Specifically, this review will synthesize data on key performance indices, including sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV**).** In addition, nasal cytology has received increasing attention as a practical diagnostic approach for characterizing inflammatory patterns in patients with rhinitis, including pediatric populations (Dodi et al., 2023), while recent evidence further highlights its potential role in the diagnosis and management of allergic rhinitis (Song et al., 2025). In addition, the review will examine the reported association between nasal eosinophil counts or proportions and the severity of allergic rhinitis to determine whether nasal smear eosinophil assessment provides clinically relevant information beyond diagnostic classification. By integrating diverse geographical data, the review seeks to determine whether NC can reliably function as a standalone diagnostic tool and whether nasal eosinophil quantification can be considered a practical indicator of disease severity**,** or if its role should be refined as a preliminary screening instrument in resource-

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limited settings. This review encompasses diagnostic accuracy studies (prospective and cross-sectional) comparing nasal cytology specifically eosinophil quantification against established gold standards (SPT or serum IgE). The scope covers both adult and pediatric populations exhibiting persistent rhinological signs. The analysis is focused on studies utilizing standard staining techniques, such as May-Grünwald-Giemsa or Wright-Giemsa, to ensure methodological consistency and reliability in the reported cellular counts.

METHOD

Eligability Criteria

This systematic review was conducted based on predefined eligibility criteria using the PICOS framework. The study population included patients exhibiting symptoms of rhinitis or those suspected of having rhinitis. The intervention of focus was nasal cytology, used to assess the composition of inflammatory cells in the nasal mucosa. Comparisons were made with standard diagnostic methods for allergic rhinitis, such as skin prick tests, measurement of serum-specific IgE, or clinical diagnosis based on established guidelines. Eligible studies were observational or diagnostic accuracy studies that evaluated nasal cytology or nasal smear eosinophil assessment for differentiating allergic and non-allergic rhinitis and reported at least one diagnostic accuracy parameter, such as sensitivity, specificity, PPV, NPV, or overall accuracy. Studies were included if they involved human participants with clinical symptoms or suspected rhinitis and provided sufficient information regarding the nasal cytology procedure and diagnostic reference or comparator. Only studies published in English between 2020 and 2025 were included. Studies were excluded if they were review articles, case reports, conference abstracts without full text, animal studies, studies without relevant nasal cytology or eosinophil data, or studies that did not provide sufficient diagnostic accuracy data.

Search Strategy

A comprehensive literature search was conducted using electronic databases, including PubMed and Google Scholar. The search strategy combined Medical Subject Headings (MeSH) terms and free-text keywords related to nasal cytology and rhinitis. The keywords used included a combination of "('nasal cytology' OR 'nasal smear') AND ('allergic rhinitis' AND 'non-allergic rhinitis') AND ('diagnostic accuracy' OR 'diagnostic value' OR sensitivity OR specificity)." The search was limited to studies published in the last five years (2020 - 2025). Additionally, the reference lists of relevant articles were manually screened to identify other eligible studies. The study selection process followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.

Data Extraction and Analysis

Data were extracted independently using a standardized data extraction form, including author and publication year, study design, sample size, nasal cytology procedure, comparator or reference standard, and diagnostic accuracy outcomes. The extracted data were synthesized qualitatively because of heterogeneity in study designs, diagnostic criteria, cytological procedures, and reported outcomes. Quantitative pooling was not performed because diagnostic parameters were not reported uniformly across the included studies. The findings were summarized descriptively, with emphasis on sensitivity, specificity, predictive values, and overall diagnostic performance.

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Risk of Bias Assessment

The methodological quality and risk of bias for each included study were assessed using the Joanna Briggs Institute (JBI) Appraisal Tools, specifically for diagnostic accuracy studies and cross-sectional studies. The assessment focused on internal validity, adequacy of the description of diagnostic procedures, and the determination of appropriate reference standards to minimize selection and measurement bias.

Intervention of interest

The primary intervention evaluated in this review is nasal cytology. This technique involves collecting a sample of nasal mucosa, typically from the inferior turbinate using a sterile cotton swab or a specialized scraper, followed by staining and microscopic examination to identify types of inflammatory cells such as eosinophils, neutrophils, lymphocytes, and mast cells. In the included studies, nasal smear samples were obtained from the nasal mucosa, particularly the inferior turbinate, using an appropriate sampling device. The collected material was transferred onto a glass slide, stained using a cytological staining technique, and examined microscopically to identify and quantify inflammatory cells, particularly eosinophils. The proportion or presence of eosinophils was subsequently interpreted as an indicator of the inflammatory pattern and compared with the diagnostic classification or reference test used in each study. Nasal cytology serves as a non-invasive, low-cost diagnostic tool that provides insight into the inflammatory profile of the nasal mucosa and can help distinguish allergic rhinitis from non-allergic rhinitis.

Outcome of interest

The primary outcome of this study is the diagnostic accuracy of nasal cytology in distinguishing between allergic and non-allergic rhinitis. Accuracy is measured by sensitivity (the ability to identify patients with allergic rhinitis) and specificity (the ability to identify subjects without allergies). Secondary outcomes include predictive values (PPV and NPV), likelihood ratios (LR+ and LR-), and the test's overall accuracy to assess the potential of nasal cytology, particularly nasal smear eosinophil assessment, as an adjunctive or initial diagnostic tool for allergic rhinitis.

RESULT AND DISCUSION

Result

1. Study selection and identification

Following the literature search, 163 articles published in the last five years were identified across three databases. Several articles were excluded due to study duplication (n = 12). During the initial screening stage, 46 records were reviewed, of which 22 were excluded based on specific criteria. From the screening results, 19 reports were sought for full-text retrieval. However, 4 reports could not be found or failed to download. Subsequently, a suitability assessment was conducted on the remaining 15 reports. At this stage, a total of 9 reports were excluded. The complete study selection process is presented in Figure 1. Ultimately, 4 articles were included in the systematic review.

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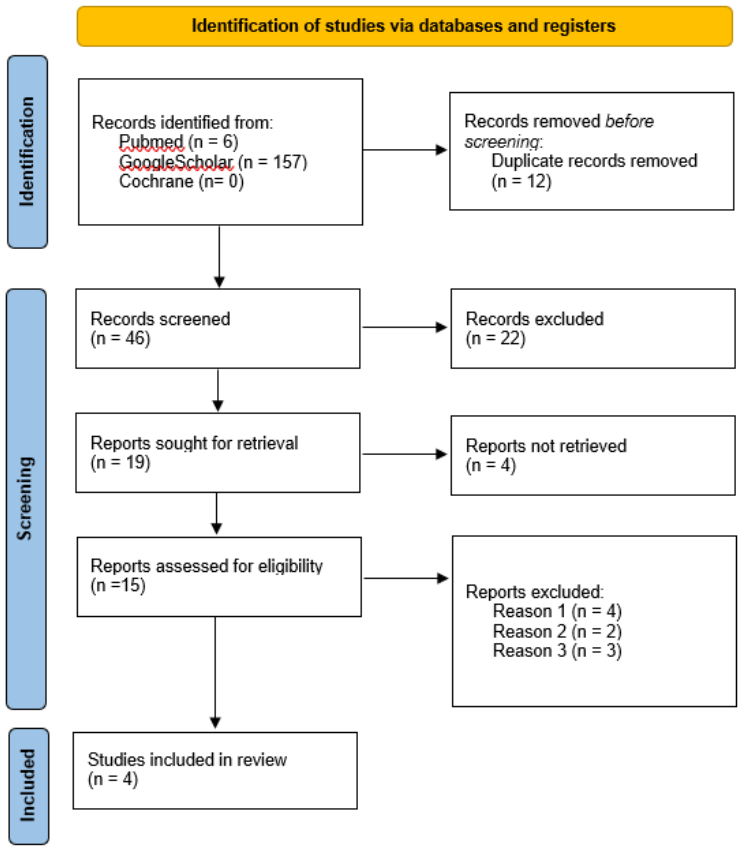

Figure 1. PRISMA Flowchart

2. Risk of Bias Assessment

The methodological quality of the included studies was evaluated using the Joanna Briggs Institute (JBI) Critical Appraisal Checklist for Analytical Cross-Sectional Studies. All four studies were classified as analytical cross-sectional studies based on their design characteristics. Two studies were assessed as having low to moderate risk of bias, demonstrating clear inclusion criteria, valid measurement of exposure (nasal cytology), and appropriate statistical analysis. The remaining two studies were categorized as having moderate risk of bias, primarily due to limitations in the reference standard used for diagnosing Allergic Rhinitis, as well as inadequate identification and control of confounding factors. Common sources of bias across studies included heterogeneity in diagnostic criteria, variability in cytological sampling and interpretation, and lack of standardized cut-off values for eosinophil counts. Despite these limitations, all studies were deemed suitable for inclusion in the systematic review.

3. Summaries of the Included Studies

A total of four studies published between 2020 and 2025 were included in this review. All studies employed observational designs, including cross-sectional and prospective approaches, and evaluated the diagnostic performance of nasal cytology in differentiating Allergic Rhinitis from Non-Allergic Rhinitis. The sample populations consisted of patients presenting with symptoms of rhinitis or suspected rhinitis. The intervention in all studies involved nasal cytology, which was used to assess the inflammatory cellular profile of the nasal

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mucosa. Comparator methods varied across studies and included clinical diagnosis, peripheral blood eosinophil counts, and standard diagnostic tests such as allergy testing.

In terms of diagnostic accuracy, nasal cytology demonstrated variable performance across studies. Reported sensitivity ranged from 37.5% to 100%, while specificity ranged from 49.6% to 87.77%. Studies utilizing more robust reference standards showed differences in diagnostic performance across the included populations**.** A consistent finding across the included studies was the association of eosinophilic predominance with allergic rhinitis, whereas neutrophilic or mixed inflammatory patterns were more commonly observed in non-allergic rhinitis. These findings support the potential role of nasal cytology as a useful adjunctive diagnostic tool, although variability in methodology and interpretation remains a limitation. The diagnostic accuracy characteristics and findings of the included studies are summarized in Table 1.

Table 1. Sumarries Included Studies

No.	Study (year)	Study Design	Duration	Interventions	Sample	Outcomes	Summary of Results
1	Atanga et al. (2023)	Diagnostic accuracy study.	5 Months	Nasal eosinophilia (index test) compared to Skin Prick Test (gold standard).	52	Sensitivity, specificity, PPV, NPV, and Youden index.	Sensitivity 37.5%, specificity 75%, PPV 83.3%, and NPV 26.4%. Diagnostic performance was deemed poor in this setting.
2	Chaudhary et al. (2024)	Comparative Prospective	Not explicitly mentioned in the source.	Nasal smear and peripheral blood eosinophil counts in allergic rhinitis patients vs. non-allergic controls.	180	Sensitivity, specificity, PPV, NPV, and accuracy.	Sensitivity 76.66%, specificity 87.77%, PPV 86.25%, and NPV 79%. A statistically significant difference was found between groups ($p < 0.05$).
3	Mahendran et al. (2025)	Comparative Prospective	Not explicitly mentioned in the source.	Nasal smear eosinophil counts compared with peripheral blood smear counts.	360	Accuracy, sensitivity, specificity, PPV, and NPV.	Sensitivity 76.64%, specificity 87.75%, PPV 86.23%, and NPV 79.00%. Accuracy was 82.27%.

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4	Ciofalo et al. (2022)	Diagnostic accuracy study.	Not explicitly mentioned in the source.	Nasal cytology to differentiate various phenotypes of persistent rhinitis (AR, NAR, CRS).	387	Sensitivity, specificity, PPV, NPV, and global accuracy.	Sensitivity 100%, specificity 49.6%, PPV 56%, and NPV 100%. Global accuracy was 69.5%.

The findings presented in Table 1 indicate considerable variability in the diagnostic performance of nasal cytology across the included studies. Sensitivity ranged from 37.5% to 100%, whereas specificity ranged from 49.6% to 87.77%. The lowest sensitivity was reported by Atanga et al. (2023), at 37.5%, despite a specificity of 75%, indicating a limited ability of nasal eosinophilia to identify allergic rhinitis in that study population. In contrast, Ciofalo et al. (2022) reported the highest sensitivity (100%) but relatively low specificity (49.6%), suggesting that nasal cytology was highly effective in identifying allergic cases but less effective in distinguishing them from non-allergic rhinitis. Chaudhary et al. (2024) and Mahendran et al. (2025) reported relatively balanced diagnostic performance, with sensitivity of 76.66% and 76.64% and specificity of 87.77% and 87.75%, respectively.

Overall, the findings suggest that the diagnostic value of nasal cytology may vary according to the study population, reference standard, and interpretation of the cytological findings. Across the studies, eosinophilic predominance was generally associated with allergic rhinitis, whereas neutrophilic or mixed inflammatory patterns were more frequently associated with non-allergic or other rhinitis phenotypes. These findings support the potential role of nasal cytology as an adjunctive diagnostic tool; however, the variation in sensitivity and specificity indicates that nasal cytology should not be interpreted independently of the clinical context and reference standard used.

Discussion

The following discussion synthesizes the findings from the four primary sources regarding the diagnostic accuracy of nasal cytology in differentiating Allergic Rhinitis (AR) from Non-Allergic Rhinitis (NAR). The primary purpose of this systematic review is to evaluate whether nasal cytology, specifically the quantification of nasal eosinophilia, serves as a reliable and accurate diagnostic alternative to the gold-standard Skin Prick Test (SPT) and serum IgE assays. he urgency of addressing this disease is underscored by its global prevalence, which affects between 10% and 54% of the population, significantly impacting the quality of life and workplace productivity (Bousquet et al., 2001; Brożek et al., 2017). The intervention involves evaluating nasal cellularity primarily eosinophils through smears obtained from nasal secretions or mucosal scraping. Key findings from the review indicate a high degree of variability in diagnostic performance; while some studies report moderate-to-high sensitivity (76.6%) and specificity (87.7%), others found poor sensitivity (37.5%), leading to the conclusion that nasal eosinophilia may be a mediocre tool in certain clinical environments. Furthermore, in specific populations with persistent symptoms, the test demonstrated a perfect sensitivity (100%) but a low specificity (49.6%), resulting in a global accuracy of approximately 69.5%. This variability is consistent with the broader literature, which indicates that the diagnostic interpretation of rhinitis depends on the inflammatory phenotype and the diagnostic method applied (Testera-Montes et al., 2021; Meng et al., 2021).

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Supporting theories for this intervention date back to the 1930s, suggesting that nasal smear eosinophilia correlates well with clinical history. Contemporary studies by Chaudhary et al. (2024) and Mahendran et al. (2025) support the use of nasal cytology as an informative first tool of contact for provisional diagnosis. his finding is also supported by Pal et al. (2017), who specifically examined the relationship between nasal smear eosinophils and allergic rhinitis, while Miri et al. (2006) demonstrated the relevance of nasal smear eosinophilia in children with allergic rhinitis. More recent studies have continued to investigate nasal cytology as a diagnostic approach, including studies evaluating its application in different rhinitis phenotypes and clinical populations (Myszkowska et al., 2022; Dodi et al., 2023; Lakshmi et al., 2025).

When compared to previous literature, the findings align with some historical data showing good correlation with SPT, yet they also reflect a long-standing debate where some researchers found conclusive associations and others found the test to be of little value (Sanli et al., 2006; Takwoingi et al., 2003). The heterogeneous findings may also reflect differences in sampling sites, as Bocciolini et al. (2023) demonstrated that the cytological findings obtained from the middle meatus may differ from those obtained from the inferior turbinate. The primary "pros" of the intervention are its economical nature, simplicity, and safety, as it carries no risk of anaphylaxis and is usable for patients of all ages. Conversely, the "cons" include its high rate of false positives in certain contexts and the lack of standardized cut-off values, which can lead to over-diagnosis or the need for additional confirmatory investigations (Atanga et al., 2023; Ciofalo et al., 2022). Recent evidence further indicates that variation in diagnostic accuracy remains an important issue, reinforcing the need to interpret nasal cytology alongside clinical findings and established allergy tests rather than as an isolated diagnostic measure (Dzafic et al., 2026).

The mechanism of action for nasal cytology is based on the pathophysiology of Allergic Rhinitis, which is an IgE-mediated Type-1 inflammatory disorder (Bousquet et al., 2001; Wise at al., 2018). Following allergen exposure, the nasal membrane undergoes mucosal inflammation characterized by tissue eosinophilia. Nasal cytology works by identifying specific cytological patterns; in AR, the predominant cells are eosinophils, followed by mast cells and basophils. This intervention is effective in managing the disease because it allows clinicians to distinguish between different phenotypes, such as non-allergic rhinitis with eosinophilia (NARES), which may share symptoms with AR but requires different management. The importance of cellular phenotyping is further emphasized by Meng et al. (2021), who described non-allergic rhinitis as a heterogeneous condition involving different immunological mechanisms. Dodi et al. (2023) similarly demonstrated the potential relevance of nasal cytology and serum atopic biomarkers in the evaluation of paediatric rhinitis. Regarding potential side effects, the procedure is described as semi-invasive or minimally invasive. Unlike the Skin Prick Test, which can occasionally trigger systemic reactions, nasal cytology is associated with no risk of anaphylaxis. The simplicity and safety of nasal cytology have also contributed to its continued investigation as a practical diagnostic approach, particularly where conventional allergy testing may be difficult to implement (Rashad et al., 2023; Lakshmi et al., 2025).

The variability in nasal eosinophil counts among patients with different degrees of symptom severity may be influenced by several clinical and environmental factors. This relationship is consistent with evidence that other inflammatory biomarkers, such as the neutrophil-to-lymphocyte ratio, may also reflect the inflammatory burden and severity of allergic rhinitis (Khanzadeh et al., 2024). Ongoing treatment, particularly the use of intranasal corticosteroids, antihistamines, or other anti-inflammatory therapies, may reduce local nasal

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inflammation and consequently decrease eosinophil recruitment, resulting in lower eosinophil counts despite persistent clinical symptoms (Patel et al., 2020). Conversely, patients who are untreated or have inadequate treatment may exhibit greater eosinophilic infiltration due to continued inflammatory responses following allergen exposure. The duration of allergic rhinitis may also contribute to differences in eosinophil levels, as prolonged or recurrent allergen exposure can maintain chronic inflammation of the nasal mucosa, although eosinophil counts do not necessarily increase proportionally with disease duration.

In addition, environmental factors such as seasonal allergen exposure, air pollution, tobacco smoke, occupational irritants, and differences in local allergen profiles may influence the intensity of nasal inflammation and produce variations in eosinophil counts between individuals and geographical settings. Therefore, the relationship between nasal eosinophilia and symptom severity should be interpreted cautiously because eosinophil counts may reflect not only the underlying allergic inflammatory process but also treatment status, disease duration, and environmental exposure. These factors may partly explain the heterogeneous diagnostic performance observed across the included studies and highlight the need for future research to control or stratify these variables when evaluating nasal eosinophilia as a potential indicator of disease severity.

The comparison between nasal and peripheral eosinophil measures is particularly relevant in this context. Sivaranjani et al. (2023) evaluated nasal smear eosinophil counts alongside absolute eosinophil counts in patients with allergic rhinitis, while Gupta et al. (2024) similarly compared nasal smear eosinophilia with absolute eosinophil counts in children. Mahendran et al. (2025) further compared eosinophil counts in peripheral blood and nasal smears between allergic and non-allergic rhinitis subjects. These studies collectively support the importance of considering local and systemic eosinophilic responses when interpreting nasal cytology findings.

Interesting insights from this review include the observation that female sex hormones and different lifestyles may influence the prevalence of allergic diseases. Additionally, the review highlights that while nasal eosinophilia is common in AR, its absence does not necessarily exclude the disease, especially in settings where allergen exposure might be intermittent. The clinical implications are significant for resource-limited settings where SPT and RAST are considered luxuries in these environments, nasal cytology serves as a critical, low-cost aid for implementing early allergen avoidance measures (Atanga et al., 2023; Ciofalo et al., 2022). The clinical usefulness of nasal cytology is particularly relevant in the context of the heterogeneous nature of rhinitis, where allergic, non-allergic, and local allergic phenotypes may present with overlapping symptoms (Mortada & Kurowski, 2023). However, clinicians must remain aware that due to its moderate specificity, a positive result may occasionally require confirmation by reference standards to avoid false-positive diagnoses. This cautious interpretation is consistent with the emerging precision-oriented approach to rhinitis diagnosis, in which clinical phenotype, inflammatory profile, and appropriate diagnostic testing are considered together rather than relying on a single marker (Meng et al., 2021; Testera-Montes et al., 2021).

The strengths of the studies included in this review lie in their ease of sample collection, quick processing times, and high patient compliance. However, several methodological weaknesses were noted, including small sample sizes and potential errors in the manual counting of cells. There was also a lack of standardization across studies regarding the techniques used for collecting nasal secretions ranging from simple swabbing to more

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sophisticated scraping which may have influenced the rate of eosinophil detection. Myszkowska et al. (2022) highlighted the diagnostic application of scraping nasal cytology, while Bocciolini et al. (2023) demonstrated that the anatomical site of sampling may also influence cytological assessment. These differences emphasize that methodological variation may contribute substantially to differences in reported diagnostic performance.

The generalizability of the findings is further limited by the specific range of allergens tested in different geographical regions and the varied cut-off values for "positivity" adopted by different researchers. The need for methodological consistency is further reinforced by Macchi et al. (2026), whose expert-based Delphi consensus addressed the standardization of nasal cytology. Standardized procedures for sampling, staining, cellular identification, counting, and interpretation may therefore improve comparability between studies and strengthen the clinical reliability of nasal cytology. Consequently, while nasal cytology remains a useful prognostic aid, more multi-institutional prospective studies with larger sample sizes and standardized protocols are necessary to reach a definitive conclusion on its global diagnostic accuracy. Future research should also clarify whether standardized eosinophil thresholds can improve the ability of nasal cytology to distinguish rhinitis phenotypes and provide clinically meaningful information regarding disease severity.

CONCLUSION

Nasal cytology serves as a valuable and cost-effective adjunctive tool for differentiating rhinitis phenotypes, particularly given the consistent association between eosinophilic predominance and Allergic Rhinitis (AR) across the included studies. However, diagnostic performance varied across studies, with reported sensitivity ranging from 37.5% to 100% and specificity from 49.6% to 87.77%, reflecting differences in study populations, sampling techniques, reference standards, and interpretation criteria. These findings indicate that nasal cytology may provide useful diagnostic information but cannot currently replace established methods such as the Skin Prick Test (SPT) or serum-specific IgE testing. Nevertheless, it may be recommended as a screening and supportive diagnostic tool, particularly in healthcare settings where standard allergy testing is not readily accessible. Its findings should be interpreted together with clinical symptoms and other diagnostic results rather than used as a standalone measure. Further studies are needed to standardize sampling procedures, interpretation protocols, and eosinophil cut-off values to improve the consistency and diagnostic reliability of nasal cytology across different populations.

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Conflict of Interest

The authors declare that there are no financial or personal conflicts of interest that could influence the objectivity or results of this systematic review.

Availability of Data and Materials

All supporting data used in this analysis, including the list of excluded articles and data extraction tables, are available within this manuscript or can be accessed upon request from the

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corresponding author. Primary data originated from public databases identified via the PRISMA protocol.

Ethics Approval and Consent to Participate

No human subjects are in this article, and informed consent is not applicable.

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