



Original Research Article

DIAGNOSTIC UTILITY OF RESPIRATORY CYTOLOGY IN LUNG MALIGNANCIES IN A TERTIARY CARE CENTRE

Jigyasu Joshi¹, Priya Parmar², Lakshita Chauhan³, Rupa Chauhan⁴

¹Assistant Professor, Department of Pathology, RNT Medical College, Udaipur, Rajasthan, India.

²Assistant Professor, Department of Pathology, RNT Medical College, Udaipur, Rajasthan, India.

³Research Scholar, Yerevan State Medical University, Armenia.

⁴Principal Chief Medical Officer, RNT Medical College, Udaipur, Rajasthan, India.

Received : 03/01/2026
Received in revised form : 07/02/2026
Accepted : 26/02/2026

Corresponding Author:

Dr. Jigyasu Joshi,
Assistant Professor, Department of Pathology, RNT Medical College, Udaipur, Rajasthan, India.
Email: drjipics2@gmail.com

DOI: 10.70034/ijmedph.2026.1.359

Source of Support: Nil,
Conflict of Interest: None declared

Int J Med Pub Health
2026; 16 (1); 2061-2065

ABSTRACT

Background: Respiratory cytology is a rapid, minimally invasive, and cost-effective diagnostic modality for evaluating pulmonary and pleural lesions. It plays a crucial role in distinguishing benign, inflammatory, and malignant conditions and aids in early diagnosis and management. **Objectives:** To evaluate the spectrum of respiratory cytology specimens and assess their diagnostic utility by correlating cytological findings with histopathological diagnosis.

Materials and Methods: This prospective observational study was conducted in the Department of Pathology at a tertiary care hospital in Udaipur, Rajasthan, from January 2025 to December 2025. A total of 430 respiratory cytology samples, including bronchoalveolar lavage (BAL), bronchial wash, lung fine needle aspiration cytology (FNAC), and pleural fluid, were analyzed. Pleural fluid samples were categorized according to the International System for Reporting Serous Fluid Cytopathology (ISRSFC), while BAL, bronchial wash, and FNAC samples were classified using the WHO reporting system. Histopathological follow-up was available in 65 cases and served as the gold standard for correlation. Diagnostic performance parameters were calculated.

Results: The majority of patients were males (70%), with most cases occurring in the middle-aged and elderly population. BAL and bronchial wash were the most common specimen types (55.8%). Most pleural fluid samples were negative for malignancy, while lung FNAC demonstrated a higher proportion of malignant diagnoses compared to BAL. Cytological findings showed high concordance with histopathology, particularly in malignant and suspicious categories. Respiratory cytology demonstrated sensitivity of 85.7%, specificity of 100%, positive predictive value of 100%, negative predictive value of 85.7%, and overall diagnostic accuracy of 92.3%.

Conclusion: Respiratory cytology is a highly specific and reliable diagnostic tool with excellent accuracy. It serves as an effective first-line modality for evaluation of respiratory lesions and facilitates early diagnosis and appropriate clinical management.

Keywords: Respiratory cytology, Bronchoalveolar lavage, Lung FNAC, Pleural fluid cytology, Histopathological correlation.

INTRODUCTION

Respiratory diseases represent a significant cause of morbidity and mortality worldwide, encompassing a wide spectrum of infectious, inflammatory, and neoplastic conditions.^[1] Lung cancer remains one of

the leading causes of cancer-related deaths globally, largely due to late presentation and delayed diagnosis.^[2] Early and accurate diagnosis is essential for appropriate management and improved patient outcomes.^[3] Cytological evaluation of respiratory specimens plays a crucial role in the initial

assessment of pulmonary lesions, offering a rapid, minimally invasive, and cost-effective diagnostic approach.^[4]

Respiratory cytology includes the examination of bronchoalveolar lavage (BAL), bronchial wash, pleural fluid, and image-guided fine needle aspiration cytology (FNAC) samples.^[5] These techniques allow direct visualization of cellular morphology and provide valuable information regarding the presence of inflammatory, infectious, or malignant processes.^[6] BAL and bronchial wash cytology are particularly useful in evaluating diffuse lung diseases and centrally located lesions, whereas image-guided FNAC is highly effective in diagnosing peripheral lung masses.^[7] Pleural fluid cytology is an essential tool in the evaluation of pleural effusions, helping to distinguish between benign and malignant etiologies.^[8]

Standardized reporting systems have been developed to improve diagnostic consistency and clinical communication. The International System for Reporting Serous Fluid Cytopathology (ISRSFC) provides a structured approach for categorizing pleural fluid cytology, while the World Health Organization (WHO) classification system is widely used for reporting respiratory cytology specimens.^[9,10] These systems enhance diagnostic reproducibility, guide clinical decision-making, and facilitate correlation with histopathological findings, which remains the gold standard for definitive diagnosis.^[11]

Despite advances in imaging and molecular diagnostics, cytology continues to play a pivotal role in the diagnostic workup of respiratory lesions, particularly in resource-limited settings.^[12] Correlation of cytological findings with histopathology is essential to evaluate the diagnostic accuracy and reliability of cytology. Therefore, the present study aimed to evaluate the spectrum of respiratory cytology specimens and assess their diagnostic utility with histopathological correlation in a tertiary care hospital.

MATERIALS AND METHODS

This was a prospective observational study conducted in the Department of Pathology at a tertiary care teaching hospital in Udaipur, Rajasthan, India, over a period of 1 year from January 2025 to December 2025.

The study included all respiratory cytology samples received in the cytopathology laboratory during the study period. A total of 430 samples, including bronchoalveolar lavage (BAL), bronchial wash, lung fine needle aspiration cytology (FNAC), and pleural fluid specimens, were included. Samples with inadequate clinical details or poorly preserved smears were excluded from the study.

Bronchoalveolar lavage and bronchial wash samples were collected during bronchoscopy by experienced

pulmonologists using standard aseptic techniques. Pleural fluid samples were obtained by thoracentesis under aseptic precautions. Lung FNAC was performed under imaging guidance, including CT-guided, ultrasound-guided, or endobronchial ultrasound (EBUS)-guided techniques, depending on lesion location.

All samples were processed according to standard cytological protocols. Fluid specimens were centrifuged, and smears were prepared from the sediment. FNAC smears were directly prepared from aspirated material. The smears were stained using May–Grünwald–Giemsa (MGG) stain and Papanicolaou (Pap) stain for cytomorphological evaluation.

Pleural fluid samples were categorized according to the International System for Reporting Serous Fluid Cytopathology (ISRSFC) into non-diagnostic, negative for malignancy, atypia of undetermined significance, suspicious for malignancy, and malignant categories. Bronchial wash, BAL, and lung FNAC samples were categorized according to the World Health Organization (WHO) reporting system into non-diagnostic/insufficient, benign, atypical, suspicious for malignancy, and malignant categories. Histopathological follow-up was obtained in cases where biopsy or surgical specimens were available. Cytological diagnoses were correlated with histopathological findings, which were considered the gold standard. Diagnostic concordance, sensitivity, specificity, positive predictive value, negative predictive value, and overall diagnostic accuracy were calculated.

Clinical details including age, gender, clinical presentation, and radiological findings were obtained from hospital records. Data were entered and analyzed using appropriate statistical methods. Descriptive statistics were used to summarize demographic and cytological findings. Diagnostic performance parameters including sensitivity, specificity, positive predictive value, negative predictive value, and diagnostic accuracy were calculated using standard formulas.

The study was conducted following approval from the Institutional Ethics Committee. Patient confidentiality was maintained, and all procedures were performed in accordance with institutional and ethical guidelines.

RESULTS

The study included 430 respiratory cytology samples, with the majority of patients belonging to the middle-aged and elderly population, particularly in the 40–60 and 60–80 years age groups. There was a clear male predominance, with males comprising approximately 70% of the study population, reflecting the higher burden of respiratory disease among males. [Table 1]

Table 1: Demographic characteristics (n = 430)

Variable	Number of Cases (n)	Percentage (%)	
Age Group (Years)	0–20	22	5.1%
	20–40	141	32.8%
	40–60	172	40.0%
	60–80	129	30.0%
	>80	8	1.9%
Gender	Male	301	70.0%
	Female	129	30.0%

Bronchoalveolar lavage and bronchial wash specimens constituted the most common sample type, accounting for more than half of all cases, followed by pleural fluid and lung FNAC. This highlights the

predominant role of BAL and bronchial wash cytology in the evaluation of respiratory tract lesions. [Table 2]

Table 2: Distribution of Respiratory Cytology Samples by Specimen Type (n = 430)

Specimen Type	Number of Cases (n)	Percentage (%)
Bronchoalveolar Lavage / Bronchial Wash (BAL/BW)	240	55.8%
Lung FNAC (EBUS / CT-guided / USG-guided)	70	16.3%
Pleural Fluid	120	27.9%
Total	430	100%

Pleural fluid cytology showed that the majority of effusions were negative for malignancy, with a smaller proportion categorized as malignant or suspicious for malignancy. Only a few cases were

classified as atypical or non-diagnostic, indicating overall good sample adequacy and diagnostic yield. [Table 3]

Table 3: Pleural Fluid Cytology Categorization Based on ISRSFC System (n = 120)

ISRSFC Category	Number of Cases (n)	Percentage (%)
Non-diagnostic	5	4.2%
Negative for Malignancy	87	72.5%
Atypia of Undetermined Significance	2	1.7%
Suspicious for Malignancy	11	9.2%
Malignant	15	12.5%
Total	120	100%

Cytological evaluation based on WHO classification revealed that benign lesions were the most frequent category in both BAL/bronchial wash and lung FNAC specimens. Lung FNAC demonstrated a

relatively higher proportion of malignant diagnoses compared to BAL, reflecting its higher diagnostic utility in suspected neoplastic lesions. [Table 4].

Table 4: Cytological Categorization Based on WHO System

WHO Category	BAL / Bronchial Wash (n=240)	Percentage (%)	Lung FNAC (n=70)	Percentage (%)
Non-diagnostic / Insufficient	2	0.8%	11	15.7%
Benign	216	90.0%	42	60.0%
Atypical	3	1.3%	0	0%
Suspicious for Malignancy	7	2.9%	0	0%
Malignant	12	5.0%	17	24.3%
Total	240	100%	70	100%

Histopathological follow-up was available in 65 cases across BAL/bronchial wash, lung FNAC, and pleural fluid specimens. [Table 5]

Table 5: Histopathological Follow-up

Specimen Type	Cases with Histopathological Follow-up (n)
BAL / Bronchial Wash	30
Lung FNAC	20
Pleural Fluid	15
Total	65

A high degree of concordance was observed between cytological and histopathological diagnoses, particularly in cases categorized as suspicious for

malignancy, which showed complete agreement. A small number of false-negative cases were observed in benign and non-diagnostic categories. [Table 6]

Table 6: Correlation of Cytology with Final Histopathological Diagnosis

Cytology Category	Total Cases with Follow-up (n)	Benign on Histopathology	Malignant on Histopathology
Non-diagnostic	15	14	1
Benign	20	16	4
Suspicious for Malignancy	30	0	30
Total	65	30	35

Respiratory cytology demonstrated high diagnostic performance, with excellent specificity and positive predictive value, along with good sensitivity and

overall diagnostic accuracy, confirming its reliability as a minimally invasive diagnostic modality for respiratory lesions (Table 7).

Table 7: Diagnostic Performance of Respiratory Cytology

Parameter	Value
Sensitivity	85.7%
Specificity	100%
Positive Predictive Value (PPV)	100%
Negative Predictive Value (NPV)	85.7%
Diagnostic Accuracy	92.3%

DISCUSSION

Respiratory cytology plays a crucial role in the initial evaluation of pulmonary lesions, providing a rapid and minimally invasive diagnostic modality. In the present study, the majority of patients belonged to the middle-aged and elderly age groups, with a clear male predominance. Similar demographic patterns have been reported in other studies, including Sareen et al., where the mean age was 57.6 years with marked male predominance, reflecting the higher incidence of respiratory malignancies among males, particularly due to smoking and occupational exposures.^[13] These findings are consistent with the known epidemiological trends of lung diseases and support the importance of cytological evaluation in this high-risk population.^[14]

In the present study, bronchoalveolar lavage and bronchial wash specimens constituted the majority of respiratory cytology samples, followed by pleural fluid and lung FNAC. This observation is comparable to the findings of Sareen et al., who also reported bronchoalveolar lavage as the most common cytological specimen received in their study.^[13] Similarly, cytological evaluation of respiratory tract specimens such as BAL, bronchial wash, FNAC, and pleural fluid has been widely recognized as the initial investigation in suspected pulmonary lesions due to its ease of collection and diagnostic utility.^[15] The predominance of BAL in both studies reflects its widespread use as a primary diagnostic tool in the evaluation of pulmonary diseases.

Pleural fluid cytology in the present study showed that the majority of cases were negative for malignancy, with a smaller proportion categorized as malignant or suspicious. This finding is consistent with previous studies, which have reported that most pleural effusions are benign in nature, with malignancy accounting for a smaller proportion.^[14] The use of standardized reporting systems such as ISRSFC improves diagnostic accuracy and helps stratify the risk of malignancy, facilitating appropriate clinical management. Furthermore,

cytological evaluation of pleural fluid remains an essential and reliable method for detecting malignant effusions and guiding further diagnostic interventions.

In the present study, lung FNAC demonstrated a higher proportion of malignant diagnoses compared to BAL and bronchial wash specimens, highlighting its superior diagnostic yield in focal pulmonary lesions. Similar observations were reported by Sareen et al., who found CT-guided FNAC to have the highest sensitivity (87.25%) and diagnostic yield compared to BAL and bronchial brush cytology.^[13] Other studies have also reported that FNAC is a simple, rapid, and reliable technique with high diagnostic efficacy in pulmonary mass lesions, particularly for peripheral tumors.^[16] These findings emphasize the importance of image-guided FNAC in improving diagnostic accuracy, especially in suspected malignancies.

The present study demonstrated high diagnostic accuracy, with excellent specificity and positive predictive value, and good sensitivity for respiratory cytology when correlated with histopathology. Similar findings have been reported in previous studies, which showed cytology to be a reasonably accurate diagnostic tool with high specificity and good sensitivity for pulmonary lesions.^[15] The absence of false-positive cases and high concordance in suspicious and malignant categories in the present study further support the reliability of cytology. Standardized reporting systems, such as the WHO classification, have been shown to improve diagnostic consistency and risk stratification, with reported specificity ranging from 96.8% to 100%.^[17] Overall, the findings of the present study reinforce the role of respiratory cytology as an effective, minimally invasive, and reliable diagnostic tool for the evaluation of pulmonary lesions, particularly when combined with histopathological correlation.

CONCLUSION

Respiratory cytology is a reliable, minimally invasive, and cost-effective diagnostic modality for the evaluation of pulmonary and pleural lesions. In the present study, respiratory cytology demonstrated high diagnostic accuracy with excellent specificity and good sensitivity when correlated with histopathological findings. Lung FNAC showed a higher diagnostic yield for malignant lesions compared to BAL and bronchial wash, while pleural fluid cytology was useful in distinguishing benign from malignant effusions. The use of standardized reporting systems such as WHO and ISRSFC improved diagnostic consistency and clinical interpretation. Overall, respiratory cytology serves as an effective first-line diagnostic tool that facilitates early detection, appropriate clinical management, and reduces the need for more invasive procedures, particularly in resource-limited settings.

Acknowledgment: None

Funding: None

Conflict of Interest: None

REFERENCES

1. Pant P, Joshi A, Shrestha BM, et al. Pattern of Respiratory Diseases, Morbidities and Outcome in Patients Admitted in Respiratory Ward of a Tertiary Care Hospital: A Descriptive Cross-sectional Study. *JNMA J Nepal Med Assoc.* 2020;58(232):1061-1054.
2. Dela Cruz CS, Tanoue LT, Matthay RA. Lung cancer: epidemiology, etiology, and prevention. *Clin Chest Med.* 2011;32(4):605-44.
3. Alharbi TAF, Rababa M, Alsuwayl H, et al. Diagnostic Challenges and Patient Safety: The Critical Role of Accuracy - A Systematic Review. *J Multidiscip Healthc.* 2025;18:3051-3064.
4. Ghildiyal S, Acharya S, Thakur B, Rawat J, Kumar R. Cytopathology of Pulmonary Lesions: A Tertiary Care Center Experience. *J Cytol.* 2018 Oct-Dec;35(4):212-216. doi: 10.4103/JOC.JOC_51_18. PMID: 30498292; PMCID: PMC6210822.
5. Siddiqui SS, Sharma T, Khurana AK, et al. N. Bronchoalveolar Lavage in Diagnostic Evaluation of Pulmonary Diseases- An Institutional Experience. *J Cytol.* 2023;40(2):68-74.
6. Jones MA, MacCuaig WM, Frickenstein AN, et al. Molecular Imaging of Inflammatory Disease. *Biomedicines.* 2021;9(2):152.
7. Tomar V, Vijay N, Nuwal P, et al. Comparative study of bronchoalveolar lavage, bronchial brushing, and FNAC in diagnosing malignant neoplasms of lungs. *J Cytol.* 2016;33(4):210-213.
8. Chen X, Li Y, Wang H, et al. Evaluation of cytomorphological examination in the diagnosis of pleural effusion. *Clin Exp Med.* 2025 Apr 10;25(1):112.
9. Wang M, Chandra A, Cai G. The International System for Reporting Serous Fluid Cytopathology-An Updated Review. *J Clin Transl Pathol.* 2023;3(4):160-177. doi: 10.14218/jctp.2023.00025. Epub 2023 Dec 20. PMID: 39372684; PMCID: PMC11451941.
10. Maleki Z, Canberk S, Field A. WHO Reporting System for Lung Cytopathology: Insights Into the Insufficient/Inadequate/Non-Diagnostic, Atypical and Suspicious for Malignancy Categories and How to Use Them. *Cytopathology.* 2025;36(5):434-442.
11. Dolezal D, Kholová I, Cai G. The World Health Organization Reporting System for Lung Cytopathology-A Review of the First Edition. *J Clin Transl Pathol.* 2024;4(1):18-35.
12. Elmas H, Önal B, Yilmaz S, et al. Optimizing Endoscopic Respiratory Diagnostics with Cytology: An Update on Touch Imprints with a Comparative Literature Review. *Diagnostics (Basel).* 2024;14(23):2750.
13. Sareen R, Pandey CL. Lung malignancy: Diagnostic accuracies of bronchoalveolar lavage, bronchial brushing, and fine needle aspiration cytology. *Lung India.* 2016;33(6):635-641.
14. Tyagi G, Malik A, Dudani S. Cytological profile in diagnosis of lung lesions and comparison with gold standard lung biopsy (TBLB). *Indian J Pathol Oncol.* 2020;7(4):601-608.
15. Ghildiyal S, Acharya S, Thakur B, et al. Cytopathology of Pulmonary Lesions: A Tertiary Care Center Experience. *J Cytol.* 2018;35(4):212-216.
16. Pachori G, Toor SS, Sharma R, et al. Utility of Image Guided Fine Needle Aspiration Cytology in Intra-Thoracic Lesions with Emphasis on Lung Cancer Detection. *J Cytol.* 2020;37(3):136-140.
17. Meena R, Nambirajan A, Mohan A, et al. Retrospective application of WHO reporting system for lung cytopathology with assessment of risk of malignancy. *J Am Soc Cytopathol.* 2024;13(3):183-193.