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Fungal isolates and their antifungal susceptibility in cases of chronic rhinosinusitis: A hospital-based observational study.

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Abstract

Background:

Chronic rhinosinusitis (CRS) is a persistent inflammatory disorder of the paranasal sinuses, and fungal involvement has gained increasing attention in recent years. Early identification of fungal etiological agents and their antifungal susceptibility patterns is essential for guiding effective therapy and improving outcomes.

Objectives:

To isolate and identify fungal pathogens in patients with chronic rhinosinusitis and to determine their antifungal susceptibility patterns along with associated clinical factors.

Methods:

This hospital-based observational study included 100 clinically diagnosed CRS patients. Sinonasal samples were obtained and processed using direct microscopy and fungal culture. Fungal isolates were identified by standard morphological methods. Antifungal susceptibility testing was performed using the CLSI guidelines. Patient demographics, clinical features, and associated comorbidities were recorded and analyzed.

Results:

The majority of patients belonged to the 31–45 year age group (44%), and 58% were males. Nasal obstruction (82%), post-nasal drip (67%), and facial pain (59%) were the common presenting symptoms. Fungal culture positivity was observed in 42% of cases. Among the isolates, Aspergillus species predominated, with *Aspergillus flavus* (42.9%) being the most frequent, followed by *A. fumigatus* (21.4%) and *A. niger* (9.5%). *Candida albicans* and *Mucor* species accounted for 14.3% and 11.9% of isolates, respectively. History of allergic rhinitis (47.6%), diabetes mellitus (28.6%), and prior steroid use (33.3%) were more frequent among fungal-positive cases. Voriconazole showed the highest susceptibility for *Aspergillus* isolates (85%), while Amphotericin-B was consistently effective for Mucor species.

Conclusion:

Fungal involvement in CRS is significant, with *Aspergillus* species being the dominant pathogens. Antifungal susceptibility testing plays a key role in guiding appropriate therapy to prevent complications.

Recommendations:

Routine fungal culture should be incorporated in CRS evaluation, especially in patients with nasal polyposis, allergic rhinitis, or diabetes. Judicious use of steroids is advised.

Keywords: *Chronic rhinosinusitis; Fungal isolates; Aspergillus species; Antifungal susceptibility; Nasal polyposis*
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Introduction

Chronic rhinosinusitis (CRS) is defined as a persistent inflammation of the nasal and paranasal sinus mucosa lasting for at least 12 weeks, despite appropriate medical care. The condition affects daily comfort, sleep, productivity, and overall quality of life. Traditionally, bacterial infection and allergic factors were considered the major contributors. However, over the past two decades, the role of fungi in CRS has become more evident, especially in regions with warm and humid climates [1–3]. Increasing use of intranasal corticosteroids, environmental exposure to airborne spores, and the growing number of patients with metabolic or immune disorders have further influenced the rise of fungal disease in the sinonasal tract [4].

Fungal CRS displays a wide clinical spectrum ranging from non-invasive forms such as allergic fungal rhinosinusitis to destructive invasive disease, particularly among immunocompromised individuals [4,5]. The symptoms often resemble those of chronic bacterial sinusitis, which may delay diagnosis unless fungal evaluation is deliberately considered. Accurate species identification and antifungal susceptibility testing are crucial because the treatment approach differs significantly from antibacterial regimens. Delayed or missed diagnosis may lead to persistent symptoms, repeated surgical interventions, and in severe situations, orbital or intracranial complications [2,4].

The distribution of fungal pathogens varies with geographic and climatic factors. Studies from India report Aspergillus species as the most frequent isolates in CRS, while *Candida* and Mucorales are more often encountered in individuals with diabetes or immune suppression [1,3,5,6]. Empirical antifungal therapy may not be reliable in these settings; therefore, culture-based confirmation and susceptibility testing are essential to guide treatment decisions effectively [1,2].

Based on this background, the present study was undertaken to determine the fungal profile in patients with chronic rhinosinusitis and to assess the antifungal susceptibility patterns of the isolates. Understanding the local fungal spectrum may assist clinicians in selecting targeted therapy and reducing recurrence.

Materials and Methods

Study Design and Setting

This hospital-based cross-sectional observational study was carried out in the Department of Otorhinolaryngology at Nimra Institute of Medical Sciences, Vijayawada, Andhra Pradesh, India, in collaboration with the Department of Microbiology. The study was conducted over 12 months from May 2024 to April 2025. Nimra Institute of Medical Sciences is a tertiary care teaching hospital serving both urban and rural populations of coastal Andhra Pradesh, with well-established ENT outpatient and surgical services and a fully equipped microbiology laboratory for fungal culture and antifungal susceptibility testing.

Study Population and Participant Selection

The study included 100 consecutive adult patients (≥18 years) clinically diagnosed with chronic rhinosinusitis. Diagnosis was based on the persistence of sinonasal symptoms for more than 12 weeks, supported by endoscopic and/or radiological evidence of mucosal inflammation. Participants were recruited from the ENT outpatient department using a consecutive sampling method after obtaining written informed consent.

Study Size

A sample size of 100 patients was selected based on feasibility, patient flow during the study period, and alignment with similar previously published hospital-based studies on fungal rhinosinusitis. This number was considered sufficient to describe the fungal profile and antifungal susceptibility patterns in the study population.

Inclusion Criteria

Patients aged 18 years and above.

Patients fulfilling the diagnostic criteria for chronic rhinosinusitis.

Patients are willing to provide informed consent and undergo sample collection.

Exclusion Criteria

Patients with acute rhinosinusitis.

Patients receiving systemic antifungal therapy within the preceding four weeks.

Patients with sinonasal malignancies.

Post-operative follow-up cases of CRS.

Data Collection and Role of Endoscopic Findings

Demographic details, clinical history, comorbidities, and prior medication use were recorded using a structured proforma. Diagnostic nasal endoscopy was performed in all patients to evaluate mucosal status, presence of discharge, and nasal polyposis. Endoscopic findings were used to guide targeted sample collection and were analyzed as associated clinical factors in fungal culture–positive cases.

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Sample Collection

Sinonasal samples were collected under aseptic precautions using sterile swabs and/or tissue specimens obtained during diagnostic nasal endoscopy or functional endoscopic sinus surgery, when indicated. Each specimen was divided for direct microscopic examination and fungal culture.

Laboratory Processing

Direct microscopy was performed using a 10% potassium hydroxide (KOH) mount to detect fungal elements. Samples were cultured on Sabouraud Dextrose Agar with and without antibiotics and incubated at 25°C and 37°C for up to four weeks. Fungal isolates were identified based on colony morphology and lactophenol cotton blue mount findings. Antifungal susceptibility testing was carried out according to CLSI guidelines using standard methods for Voriconazole, Itraconazole, Amphotericin-B, and Fluconazole.

Bias Control

Selection bias was minimized by enrolling consecutive eligible patients. Information bias was reduced through standardized clinical evaluation, uniform sampling techniques, and adherence to established laboratory protocols. Antifungal susceptibility testing, culture, and identification were performed following CLSI recommendations to ensure consistency and reliability.

Data Analysis and Missing Data

Collected data were entered and analyzed using descriptive statistical methods. Results were expressed as frequencies and percentages. Patients with incomplete clinical or laboratory records were excluded from the final analysis. As complete data were available for all included participants, no imputation for missing data was required.

Ethical Considerations

The study was approved by the Institutional Ethics Committee of Nimra Institute of Medical Sciences, Vijayawada. Written informed consent was obtained from all participants before enrollment.

RESULTS

A total of 112 patients presenting with symptoms suggestive of chronic rhinosinusitis were initially assessed for eligibility during the study period. Of these, 12 patients were excluded: 5 had acute rhinosinusitis, 4 had received systemic antifungal therapy within the preceding four weeks, and 3 declined to provide informed consent. The remaining 100 patients fulfilled the diagnostic criteria for chronic rhinosinusitis and were enrolled in the study. All enrolled participants underwent clinical evaluation, diagnostic nasal endoscopy, and microbiological sampling. Complete clinical and laboratory data were available for all 100 patients, and all were included in the final analysis.

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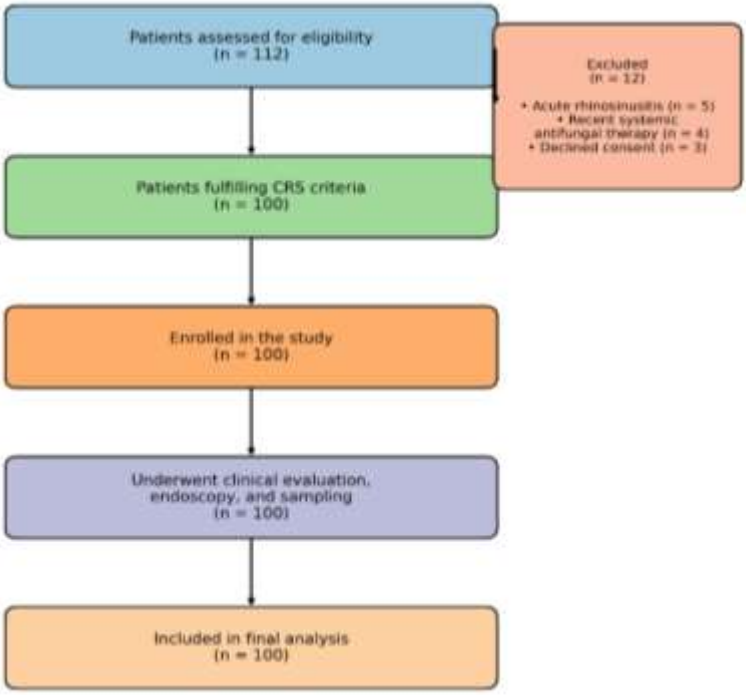

Figure 1: Participant Flow Diagram

A total of 100 patients with clinically diagnosed chronic rhinosinusitis were included in the present study. The demographic and clinical characteristics of the study participants are shown in Table 1. The mean age of the study group was 38.4 ± 11.6 years, with a higher proportion of cases observed in the 31–45 year age group (44%). Males constituted 58% of the study population. Nasal obstruction (82%) was the most frequently reported symptom, followed by post-nasal drip (67%) and facial pain/pressure (59%).

Table 1: Demographic and Clinical Characteristics of the Study Population (n = 100)

Parameter	Number	Percentage (%)
Gender		
Male	58	58
Female	42	42
Age Group (Years)		
18–30	26	26
31–45	44	44
46–60	24	24
>60	6	6
Presenting Symptoms		
Nasal obstruction	82	82
Post-nasal drip	67	67
Facial pain/pressure	59	59
Hyposmia/Anosmia	48	48
Headache	41	41

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Fungal culture was positive in 42% of cases, while 58% of samples did not yield any fungal growth (Table 2). Among the culture-positive isolates, Aspergillus species were the most commonly identified, accounting for the majority of cases. *Aspergillus flavus* was the predominant isolate (42.9%), followed by *A. fumigatus* (21.4%) and *A. niger* (9.5%). *Candida albicans* and *Mucor* species were isolated in 14.3% and 11.9% of cases, respectively (Table 2).

Table 2: Fungal Culture Positivity and Type of Fungal Isolate (n = 100)

Culture Result / Fungal Species	**Number**	**Percentage (%)**
Culture Positive Cases	42	42
Culture Negative Cases	58	58
Distribution of Fungal Isolates (n = 42)		
Aspergillus flavus	18	42.9
Aspergillus fumigatus	9	21.4
Aspergillus niger	4	9.5
Candida albicans	6	14.3
Mucor species	5	11.9

Clinical factors associated with fungal-positive cases are summarized in Table 3. A history of allergic rhinitis was present in 47.6% of fungal-positive patients. Diabetes mellitus was noted in 28.6% of cases, and prior use of systemic or local corticosteroids was seen in 33.3% of fungal-positive individuals. Nasal polyposis on endoscopic examination was seen in a majority (61.9%) of culture-positive cases.

Table 3: Association of Clinical Factors in Fungal-Positive Cases (n = 42)

Clinical Factor	**Number**	**Percentage (%)**
History of allergic rhinitis	20	47.6
Diabetes mellitus	12	28.6
Prior steroid (local/systemic) use	14	33.3
Nasal polyposis on endoscopy	26	61.9

The antifungal susceptibility pattern of the isolates is presented in Table 4. Voriconazole exhibited the highest susceptibility among *Aspergillus* species (85%), followed by Amphotericin-B (79%) and Itraconazole (71%). Fluconazole showed poor activity against *Aspergillus* isolates, with only 24% demonstrating susceptibility. All Mucor isolates were 100% sensitive to Amphotericin-B, while Candida albicans isolates showed high susceptibility to Voriconazole (92%) and Fluconazole (91%).

Table 4: Antifungal Susceptibility Pattern of Isolates (%)

Antifungal Agent	***Aspergillus* spp. Sensitive**	***Aspergillus* spp. Resistant**	***Candida albicans* Sensitive**	***Mucor* Sensitive**
Voriconazole	85	15	92	–
Itraconazole	71	29	76	–
Amphotericin-B	79	21	–	100
Fluconazole	24	76	91	–

DISCUSSION

In this study, fungal involvement was detected in 42% of patients with chronic rhinosinusitis, indicating that fungi constitute an important etiological component in our region. The predominance of adults in the 31–45 year age group and the higher proportion of males were comparable to previous

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Indian reports, where similar demographic patterns have been described. The common presenting symptoms, nasal obstruction, post-nasal drip, and facial pressure are consistent with established clinical features of CRS, regardless of microbial cause.

Among culture-positive cases, Aspergillus species were the most frequent isolates, with *Aspergillus flavus* emerging as the leading pathogen. This observation parallels earlier studies from India and South Asia, where *A. flavus* has been consistently reported as a dominant sinonasal isolate in warm, humid climates [7,8,12]. The detection of Mucor species in a smaller proportion of cases, though less common, is clinically relevant, especially considering the possibility of invasive disease in patients with metabolic risk factors. The association between diabetes mellitus, prior corticosteroid exposure, and fungal sinus disease has also been highlighted in earlier clinicomycological analyses [9,11,12].

In the present study, a higher rate of fungal positivity was observed in patients with allergic rhinitis and nasal polyposis, supporting the role of persistent mucosal inflammation in enabling fungal persistence. These findings reinforce the importance of evaluating individual host factors when assessing CRS etiology, as also emphasized in recent regional research [11,12].

The antifungal susceptibility pattern in this study demonstrated excellent activity of Voriconazole against *Aspergillus* isolates, consistent with previous susceptibility studies from tertiary centers [7,8,13]. Amphotericin-B remained the most reliable agent against Mucor species, in agreement with established therapeutic recommendations for mucormycosis management [10]. In contrast, Fluconazole showed poor effectiveness against filamentous fungi, a pattern well documented in the literature [7,8]. These data further support the need for species identification and susceptibility testing, avoiding empirical antifungal therapy, particularly in suspected mold-driven CRS [13,14].

Generalizability

The findings reflect patterns observed in similar tertiary-care settings in humid, tropical regions where fungal sinus disease is common. Results may be generalizable to comparable populations with similar environmental exposure and risk profiles; however, variations in climate, referral patterns, and laboratory capacity may limit broader applicability.

Conclusion

This study confirms that fungal pathogens contribute substantially to chronic rhinosinusitis, with *Aspergillus* species being the predominant isolates. Nearly half of the patients with CRS showed culture positivity, highlighting the value of routine mycological evaluation. Factors such as allergic rhinitis, diabetes, prior steroid use, and nasal polyposis were more frequently associated with fungal involvement, indicating the need for careful clinical assessment of at-risk individuals. Voriconazole demonstrated reliable activity against *Aspergillus*, while Amphotericin-B remained the treatment of choice for *Mucor* infections. Fluconazole showed limited usefulness for filamentous fungi. Incorporating fungal culture and susceptibility testing into routine CRS management can support timely, targeted therapy and improve long-term clinical outcomes.

Limitations

This study was conducted in a single tertiary-care center, which limits the wider applicability of the findings. The sample size, though adequate for descriptive analysis, may not fully capture regional variability in fungal species distribution. Advanced molecular diagnostic techniques were not used, which could have detected additional or mixed fungal pathogens. The study did not include long-term follow-up to assess treatment response or recurrence. Antifungal susceptibility testing was limited to commonly available drugs.

Recommendations

Routine fungal culture and microscopy should be considered in all patients with chronic rhinosinusitis, particularly those with nasal polyposis, allergic rhinitis, diabetes, or prior steroid exposure. Early identification of fungal species can guide timely and specific antifungal therapy. Voriconazole may be preferred for *Aspergillus* infections, whereas Amphotericin-B should be used for suspected or proven *Mucor* involvement. Empirical use of Fluconazole for CRS is discouraged due to poor activity against filamentous fungi. Clinicians should monitor high-risk patients closely and educate them on minimizing environmental exposures. Incorporating multidisciplinary care may further reduce recurrence and improve overall outcomes.

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guidance throughout the study. We thank all the patients who participated. We also acknowledge the laboratory staff for their assistance in specimen processing and culture work.

Abbreviations

CRS – Chronic Rhinosinusitis
KOH – Potassium Hydroxide
SDA – Sabouraud Dextrose Agar
LPCB – Lactophenol Cotton Blue
MIC – Minimum Inhibitory Concentration
CLSI – Clinical and Laboratory Standards Institute
ENT – Ear, Nose, and Throat

Source of funding

The study had no funding.

Conflict of interest

The authors declare no conflict of interest.

Author contributions

MAS-Concept and design of the study, results interpretation, review of literature, and preparing the first draft of the manuscript. Statistical analysis and interpretation, revision of manuscript. **KBM**-Concept and design of the study, results interpretation, review of literature, and preparing the first draft of the manuscript, revision of the manuscript.**SBS**-Review of literature and preparing the first draft of the manuscript. Statistical analysis and interpretation. **KV**-review of literature and preparing the first draft of the manuscript. Statistical analysis and interpretation, revision of manuscript.

Data availability

Data available upon request

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