Research Journal of Recent Sciences ISSN 2277-2502
Vol. **15(1),** 1-4, January **(2026)** *Res. J. Recent Sci.*

Indoor Airborne Diversity of Allergenic Fungal Bioaerosols from Medical College Hospital, Amravati, MS, India

Vaishnavi Anilrao Ingale[1*] and Dilip Vinayakrao Hande[2]
[1]Department of Botany, Faculty of Mycology, Shri Shivaji Science College, Amravati, Maharashtra, India
[2]Mahatma Fule Arts, Commerce & Sitaramji Chaudhari Science College, Warud, District Amravati, Maharashtra, India
vaishnaviingle997@gmail.com

Available online at: www.isca.in, www.isca.me
Received 11th October 2025, revised 18th November 2025, accepted 30th December 2025

Abstract

In June 2025, this investigation assessed airborne allergenic fungal bioaerosols across five wards of the Medical College Hospital in Amravati. Air samples were gathered via the settle-plate technique on Potato Dextrose Agar (PDA), and the fungal colonies were subsequently identified based on microscopic and morphological characteristics. Nine fungal species were detected, mainly from Aspergillus, Penicillium, Rhizopus, Alternaria, Fusarium, Cladosporium, and Curvularia. Aspergillus flavus, A. fumigatus, and A. niger were detected in all wards, indicating their dominance in hospital air. Cladosporium cladosporioides and Curvularia lunata were common in Dermatology and Gynecology wards, while Penicillium Spp. and Fusarium oxysporum were common in Orthopedics. Alternaria alternata was abundant in the Pediatric ward, and Rhizopus stolonifer appeared mainly in Medicine and Gynecology wards. The variation in fungal presence was linked to humidity, ventilation, and hygiene. Many species are allergenic or opportunistic pathogens, posing health risks to immunocompromised patients. Continuous air monitoring and environmental control are recommended to maintain hospital safety.

Keywords: Bioaerosols, Allergenic Fungi, Hospital, *Aspergillus,* Wards.

Introduction

Fungi play a vital ecological role by decomposing and recycling organic matter. These chitin-walled, heterotrophic eukaryotes inhabit diverse environments and often form symbiotic relationships. A major contributor to bioaerosols, fungal spores called airspora make up 80–90% of airborne biological particles. Fungal bioaerosols are mainly molds with hyphal mycelium. Ascomycetes, Zygomycota, and Deuteromycota differ in reproduction, aiding efficient wind-driven spore dispersal. Fungal spore concentrations in the air are heavily influenced by environmental factors such as temperature, humidity, light, rainfall, and the availability of organic matter. These conditions vary by season and geography, resulting in seasonal changes in fungal diversity and density.

Certain allergenic genera, such as *Aspergillus*, *Alternaria*, *Cladosporium*, and *Penicillium*, commonly appear in air samples, particularly during warm and humid periods. High humidity supports basidiospore production, whereas drier conditions favor spores like *Alternaria*. Climate change and elevated temperatures may further enhance spore production, increasing human exposure risks.

Local meteorological and geographical factors lead to diverse airborne spore compositions, with genera linked to allergies such as *Alternaria, Aspergillus, Cladosporium*, and *Penicillium* being prevalent[1].

Breathing in airborne fungal spores may trigger allergic reactions and infections—especially in people who are sensitive to mold or whose immune systems are compromised. While healthy people often remain unaffected, immune compromised individuals risk developing severe respiratory or systemic infections. On average, humans inhale about 200 spores daily, some reaching the lungs[2]. Opportunistic fungi like *Aspergillus*, *Penicillium*, and *Mucor* can cause illnesses ranging from mild allergies to life-threatening conditions, especially in patients undergoing chemotherapy or organ transplants. Mycotoxins produced by molds pose serious health risks, including carcinogenic, teratogenic, and neurotoxic effects. Fungi also release allergenic proteins and cell wall components like glucan and chitin, which can trigger IgE-mediated hypersensitivity reactions such as asthma and dermatitis.

Healthcare settings contaminated with filamentous fungi present a risk, since these organisms can cause opportunistic infections in patients whose immunity is weakened—such as those recovering from surgery, receiving hematopoietic stem cell transplants, or living with hematological cancers[3]. Several hospitals throughout India have documented a rise in post-COVID mucormycosis cases[4]. Hospitals are particularly vulnerable to fungal contamination because of enclosed spaces, high occupancy, and immunocompromised patients. Spores may enter through HVAC systems, staff, or visitors, increasing the risk of nosocomial infections. Occupational exposure to fungi is also common in agriculture, laboratories, and healthcare settings. Given these risks, regular indoor air monitoring is essential to prevent fungal-related health issues and to safeguard vulnerable populations. Crowded environments, such as hospitals, are especially suitable for fungal infections[5]. Therefore, these places should be monitored routinely[6].

Materials and Methods

Study Locations: The investigation was carried out at five designated indoor areas within Medical College Hospital, Amravati in month of June, 2025. These included various clinical settings such as dermatology, orthopedic, medicine, pediatric, and gynecology wards. Site selection was based on patient exposure risk, including factors such as compromised immunity, surgical intervention, and the need for high-level sterility.

Air Sampling Method: Airborne fungal spores were collected using the settle plate technique[7,8]. Nutrient-rich Petri dishes containing Potato Dextrose Agar (PDA) were exposed to the ambient air for 10 to 15 minutes at a height of roughly one meter, approximating the breathing zone of room occupants. During this exposure, environmental variables such as temperature, humidity, and rainfall were recorded to evaluate their impact on fungal spore dispersal. After the exposure period, the agar plates were sealed, labeled, and transported to the laboratory under sterile handling conditions.

Incubation and Growth Observation: Under an incubation temperature of 28±1°C, the PDA plates were monitored for fungal growth on days 3, 5, and 7. Colony-forming units (CFUs) were counted, and prominent colonies were selected for isolation and further study.

Fungal Isolation and Maintenance: Selected colonies were carefully transferred onto fresh PDA plates using aseptic techniques to develop pure cultures. These isolates were maintained through routine sub-culturing to ensure their stability and viability for detailed examination.

Microscopic and Macroscopic Analysis: For microscopic identification, Lactophenol Cotton Blue (LPCB) staining was employed. Slides were prepared by placing portions of mycelium or spores on glass slides, stained, and examined under a compound microscope. Observations focused on spore morphology, hyphal arrangement, and reproductive structures. Additionally, each isolate's colony appearance—such as surface and reverse pigmentation, growth texture, and spore features—was recorded to support accurate identification.

Fungal Identification: Identification of the fungal isolates was conducted by correlating morphological and microscopic observations with established taxonomic references, primarily using key[9]. Each fungal strain was classified to the genus or species level where possible, enabling a comprehensive assessment of fungal diversity in the hospital's indoor air.

The percentage contribution of each species was determined using the standard calculation formula. Total number of colonies belonging to a single species:

$$\% \text{ contribution of a species} = \frac{\text{Number of colonies of that species}}{\text{Total number of colonies of all species}} \times 100$$

Results and Discussion

Results of our studies are given in Table-1 and Table-2.

Table-1: Indoor Airborne Diversity of Allergenic Fungal Bioaerosols in selected wards.

Genus	Species	Characteristics	Description
Aspergillus spp.	1. *A. flavus* 2. *A. fumigatus* 3. *A. niger*	Dry conidia, high sporulation	Major allergen, causes aspergillosis
Penicillium spp.	Unidentified	Green colonies, dry spores	Allergic bronchopulmonary disease
Rhizopus spp.	*R. stolonifer*	Sporangiospores, fast growing	Causes Mucormycosis
Alternaria spp	*A. alternate*	Dark septate conidia, dry spores	Strong allergen, causes rhinitis
Fusarium spp.	*F. oxyporum*	Slimy spores, fast growing	Opportunistic pathogen, keratitis
Cladosporium spp.	*C. cladosporioides*	Pigmented spores, common outdoors	Potent allergen, asthma trigger
Curvularia spp.	*C. lunata*	Dematiaceous, curved conidia	Allergic fungal sinusitis

Table-2: The total count and percentage contribution of fungal colony from indoor environment of Wards.

Fungal Species	Dermatology (Count)	Dermatology (%)	Orthopedic (Count)	Orthopedic (%)	Medicine (Count)	Medicine (%)	Pediatric (Count)	Pediatric (%)	Gynecology (Count)	Gynecology (%)
Aspergillus flavus	3	10.34	2	7.14	4	13.33	2	6.67	4	14.29
Aspergillus fumigatus	3	10.34	4	14.29	2	6.67	5	16.67	2	7.14
Aspergillus niger	4	13.79	2	7.14	2	6.67	2	6.67	2	7.14
Penicillium spp.	1	3.45	5	17.86	5	16.67	5	16.67	3	10.71
Rhizopus stolonifer	3	10.34	3	10.71	4	13.33	3	10.00	5	17.86
Alternaria alternata	4	13.79	3	10.71	4	13.33	5	16.67	3	10.71
Fusarium oxysporum	1	3.45	5	17.86	2	6.67	3	10.00	1	3.57
Cladosporium cladosporioides	5	17.24	2	7.14	5	16.67	3	10.00	5	17.86
Curvularia lunata	5	17.24	2	7.14	2	6.67	2	6.67	3	10.71

Discussion: This study outlines the presence and distribution of airborne allergenic fungal bioaerosols within selected wards of Medical College Hospital, Amravati. The detection of nine distinct fungal species across five hospital wards highlights the importance of consistent indoor air monitoring, particularly in environments that house patients with compromised immune systems.

Overview of Fungal Isolates: The fungal species found in this study are similar to those usually seen in indoor air, especially in hospitals. Many of these fungi can worsen allergies or sometimes cause infections in people with weak immunity.

The species *Aspergillus flavus*, *Aspergillus fumigatus*, and *Aspergillus niger* were detected in every ward of the hospital. This shows that *Aspergillus* is very common and can survive in different conditions. Earlier studies also report that *Aspergillus* is widely found in hospital environments, especially where humidity and airflow change from place to place.

Cladosporium cladosporioides was one of the most common fungi, especially in the Dermatology and Gynecology wards. *Cladosporium* grows well in damp areas with poor ventilation and is known to trigger allergies.

Curvularia lunata was also found often, mostly in the Dermatology ward. This fungus is linked to allergic sinus problems and sometimes eye infections.

Fungal Distribution by Ward: Table-2 illustrates distinct fungal profiles for each ward: i. The Dermatology Ward recorded the greatest fungal variety, with significant contributions from *Cladosporium*, *Curvularia*, and *Aspergillus*. This is likely due to the presence of patients with skin lesions and chronic infections, making the ward more vulnerable to fungal colonization. ii. In the Orthopedic Ward, *Penicillium* spp. and *Fusarium oxysporum* had the highest presence. These fungi are often linked to environmental dust and may pose risks for patients recovering from surgeries or with implanted devices. iii. The Medicine Ward, catering to patients with systemic conditions like diabetes and respiratory disorders, showed notable levels of *Aspergillus*, *Rhizopus*, and *Cladosporium*. These genera are known for their opportunistic pathogenicity, especially in immunocompromised individuals. iv. The Pediatric Ward had elevated levels of *Alternaria alternata* and *Penicillium* spp., both of which are associated with allergic respiratory symptoms. This is concerning due to the heightened vulnerability of children to airborne allergens. v. The Gynecology Ward showed higher proportions of *Rhizopus stolonifer* and *Cladosporium cladosporioides*. These findings are significant given the ward's patient population, which includes postpartum women who may be immunologically sensitive.

Health Significance: Although many of the detected fungi are primarily allergenic, some—including *Aspergillus*, *Rhizopus*, and *Fusarium*—can cause serious infections in patients with weakened immune defenses. Notably, *Rhizopus stolonifer* was found in greater proportions in the Medicine and Gynecology wards, pointing to potential risks for mucormycosis, particularly in post-surgical or immunocompromised patients.

The variability in fungal distribution across wards suggests that indoor microbial diversity is influenced by ward-specific factors such as patient density, environmental control systems, humidity levels, and housekeeping protocols. The presence of *Aspergillus*, *Fusarium*, and *Mucor* species is concerning because these fungi are associated with a high risk of severe and potentially life-threatening invasive infections, including aspergillosis, fusariosis, and zygomycosis[10].

Need for Environmental Control: These results emphasize the importance of ongoing fungal surveillance in hospital settings. Periodic monitoring allows for early identification and timely intervention to minimize fungal growth—such as improving ventilation, controlling humidity, and routine maintenance of air systems. Targeted infection control practices are particularly essential in high-risk areas like ICUs and surgical theatres.

Conclusion

This study highlights the need for continuous monitoring of airborne fungal bioaerosols in hospital environments. Various allergenic and pathogenic fungi—including *Aspergillus*, *Cladosporium*, *Penicillium*, *Rhizopus*, and *Fusarium*—were detected across wards, influenced by factors like humidity, ventilation, and cleanliness. The consistent presence of *Aspergillus* and other opportunistic species poses risks, particularly for immunocompromised patients. Therefore, maintaining proper ventilation, humidity control, and regular air quality checks is essential to prevent fungal growth and ensure a safer hospital environment.

References

1. Fukutomi, Y., & Taniguchi, M. (2015). Sensitization to fungal allergens: resolved and unresolved issues. *Allergology International*, 64(4), 321-331.

2. Latgé, J. P. (1999). Aspergillus fumigatus and aspergillosis. *Clinical microbiology reviews*, 12(2), 310-350.

3. Hasnain, S. M., Akhter, T., & Waqar, M. A. (2012). Airborne and allergenic fungal spores of the Karachi environment and their correlation with meteorological factors.3 *Journal of Environmental Monitoring*, 14(3), 1006-1013.

4. Nambiar, M., Varma, S. R., & Damdoum, M. (2021). Post-Covid alliance-mucormycosis, a fatal sequel to the pandemic in India. *Saudi Journal of Biological Sciences*, 28(11), 6461-6464.

5. Li, C. S. & Hou, P. A. (2003). Bioaerosol characteristics in hospital clean rooms. *Science of the Total Environment*, 305(1-3), 169-176.

6. Sarıca, S., Asan, A., Otkun, M. T., & Ture, M. (2002). Monitoring indoor airborne fungi and bacteria in the different areas of Trakya University Hospital, Edirne, Turkey. *Indoor and built Environment*, 11(5), 285-292.

7. Ekhaise, F. O. & Ogboghodo, B. I. (2011). Microbiological indoor and outdoor air quality of two major hospitals in Benin City, Nigeria. *Sierra Leone Journal of Biomedical Research*, 3(3), 169-174.

8. Bhatia, L., & Vishwakarma, R. (2010). Hospital indoor airborne microflora in private and government-owned hospitals in Sagar City, India. *World Journal of Medical Sciences*, 5(3), 65-70.

9. Barnett, H. L., & Hunter, B. B. (1972). Illustrated genera of imperfect fungi.

10. Mayayo, E., Landeyro, J., Stchigel, A. M., Gazzoni, A., & Capilla, J. (2010). Infiltración perineural por célulasfúngicas. Presentación de un caso y revisión de la literatura. *RevistaIberoamericana de Micología*, 27(2), 94-97.