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Assessment of airborne fungal pollution in a hospital room

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Abstract

Hospitals and other health care facilities are designed to fight various diseases and to provide complete patient care. Now days it has been a tremendous increase in hospital acquired infections, especially those caused by fungi. To reduce these incidences routine proper monitoring is required. Therefore, present study was performed to detect the current airborne fungal load and the influence of meteorological factors on their concentrations in a hospital outdoor patient room. A total of 8 fungal species were isolated among which Aspergillus showed dominance. Quantitative and qualitative seasonal variation in airborne fungal load was also observed.

Keywords: Hospital, Indoor, Airborne, *Aspergillus*, Allergies.

Introduction

The presence of airborne fungi in hospital environment and other health care settings has been emphasized in past decades due to their impact on human health. Fungal infections of hospital have been gaining more attention due to their progressive increase and morbidity and mortality associated to it[1]. They have been involved in various clinical manifestation ranging from allergies to fatal disseminated infections in susceptible patients. In the hospital environment, the aeromycospora is formed mainly by filamentous fungi, especially those from the genera *Aspergillus, Cladosporium, Paecilomyces, Penicillium, Scopulariopsis*[2,3]. Yeasts have also been found, belonging to *Candida, Rhodotorula, Cryptococcus* and *Trichosporon* genera[4-6]. Different authors have also reported presence of airborne fungi in different wards and medical units where the risk of fungal infections is highest[7-9]. Various studies have also suggested that the distribution of fungi in the air, varies among different geographic areas, and is also influenced by various seasonal and climatic factors, time, wind speed and its direction, presence of human activity, and type of ventilation[10,11]. Therefore, the aim of the present study was to evaluate the variability and the effect of meteorological parameters (temp and humidity) on the airborne fungi of a hospital outdoor patient room within a period of one year.

Materials and methods

Sampling site: An outdoor patient room of a three storey private hospital was selected as an indoor sampling site. The sampling room was on ground floor with no mechanical ventilation system. Every day high number of people visiting in this room which serve as potential source of airborne micro-organisms. In addition, poor ventilation might also increase indoor rate of airborne microorganisms.

Sampling Procedure: Air samples were collected monthly for the period of one year using the settle plate method. Plates of Potato dextrose agar (PDA) supplemented with 10 mg/L chlormphenicol were used for the isolation of fungi. All the plates were kept at a height of 1.5m from the floor (human breathing zone)[12] and exposed in the air for a period of 30 minutes. The plates were then incubated at 25^0C for 5-7 days. After that, the total number of colony forming unit (CFU) was calculated and converted to colony forming unit per cubic meter (CFU/m^3) of air. Identification of fungi was done, initially on the basis of colonial appearance and then a wet mount preparation of each colony was prepared by using Lactophenol-cotton-blue solution. Finally they were identified under microscope on the basis of spore and hyphal characteristics[13].

Meteorological Data: During the whole study, both temperature and humidity were measured monthly. Temperature ranged between 25-37.1°C whereas, humidity ranged between 42-88% at sampling site (Table-1).

Statistical Analysis: In the present study, the impact and degree of effectiveness of meteorological parameters (temperature and humidity) on airborne fungal concentration was estimated using Pearson's correlation coefficient[14]. The statistical significant difference in the concentration of fungi among the months and among the samples was also determined by one-way ANOVA test.

Results and discussion

The mean monthly concentrations of total airborne fungi in the hospital, are presented in Figure-1. The concentration of airborne fungi ranged from 26.66–50.83 cfu/m^3 with the lowest value in March and very distinct peak in December. *Aspergillus* sp. dominated among the fungus and formed 42.65% of total fungal count. The genera comprised *A.niger, A.flavus* and *A.fumigatus*. Other fungal isolates were *Alternaria solani, Cladosporium herbarum, Fusarium oxysporum, Helminthosporium sp.,* and *Rhizopus sp.,* which constituted 57.35% of total fungal count.

Table-1: Monthly ambient temperature and relative humidity recorded at hospital.

Months	Temperature (°C)	Relative Humidity (%)
July	36.0	79
August	32.2	85
September	32.4	88
October	35.7	67
November	27.4	75
December	25.5	71
January	25.0	70
February	29.0	74
March	32.8	55
April	36.2	42
May	37.1	64
June	36.4	69

Seasonal fluctuation in different type of fungus was also recorded. *Aspergillus* sp. was found in high concentrations in summer (Figure-4). Whereas in monsoon season *Cladosporium herbarum* (Figure-2), and in winter *Alternaria solani* were in higher counts (Figure-3).

Correlation of temperature was found positively strong with total *Aspergillus* count (r=0.692829) but negatively strong with both total airborne fungal count (r=-0.72212) and other fungal species count (r=-0.81443) whereas, humidity was found correlated positively strong with both total fungal count (r=0.593231), and other fungal species (r=0.565103), but negatively weak with total *Aspergillus* count (r=-0.36541) (Table-2).

Table-2: Correlation coefficients ('r') showing the effect of meteorological parameters on fungal concentrations at hospital.

	Total airborne fungal count	Total *Aspergillus* Count	Other fungal sp. count
Temperature	-0.72212	0.692829	-0.81443
Humidity	0.593231	-0.36541	0.565103

From the analysis of variance (ANOVA) (Table-3) under degree of freedom of V1=11, V2=24, the F value of 14.56 and the critical value (Fcv) of 2.22 were obtained. Thus, Ho could be rejected in favour of Ha. This showed that the difference in the concentration of airborne fungi among the months and among the samples was substantially significant.

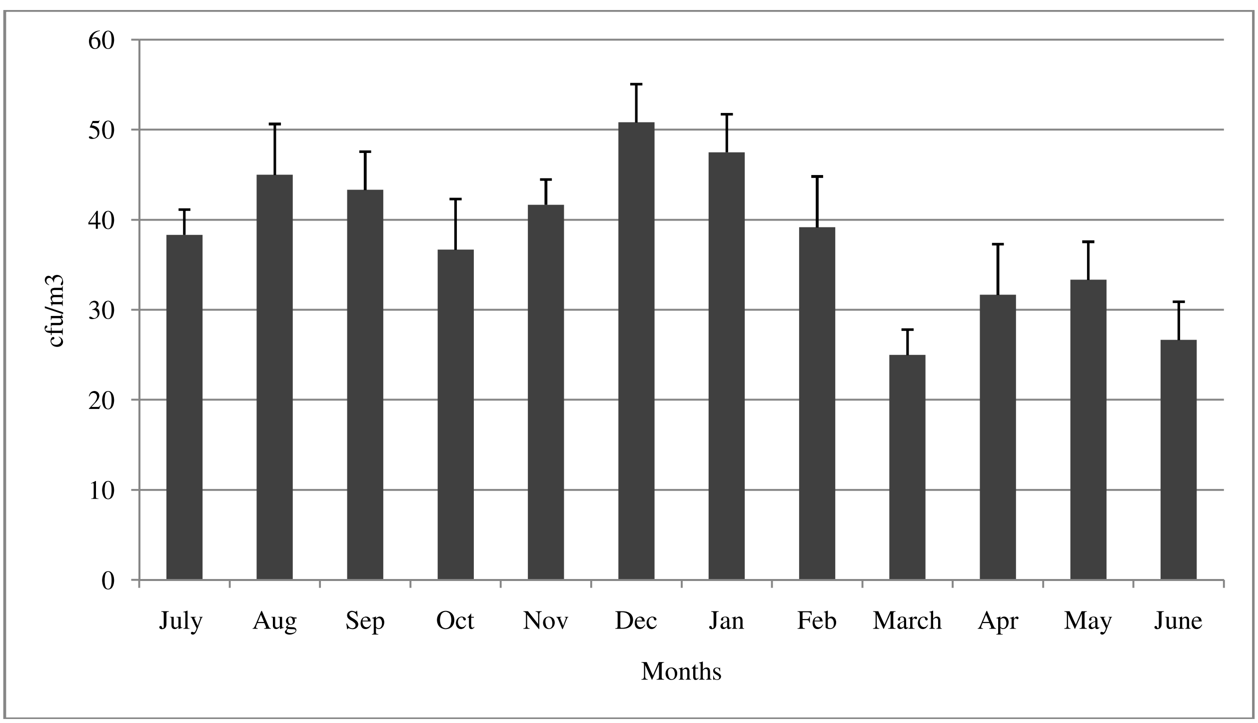

Figure-1: Monthly fluctuation in concentration of total airborne fungi in Hospital (mean ± S.D.).

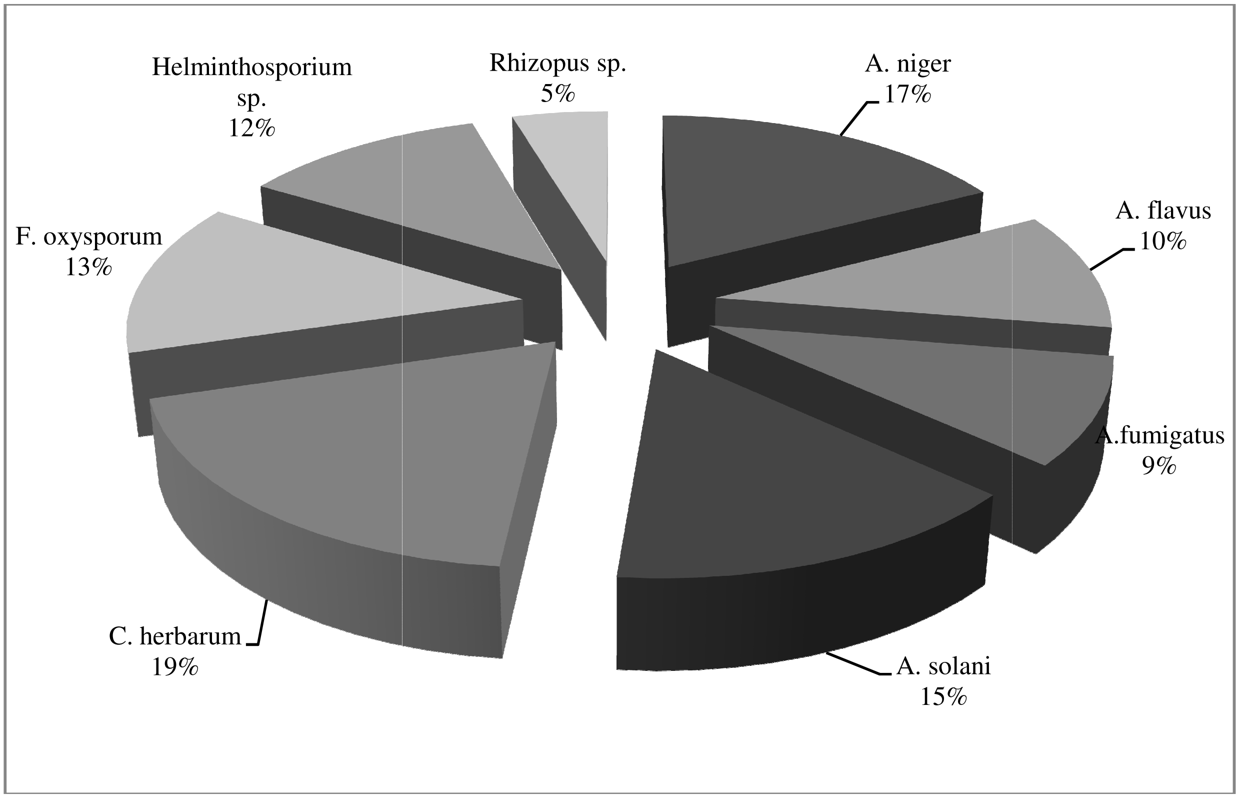

Figure-2: Distribution pattern of various fungal species in monsoon.

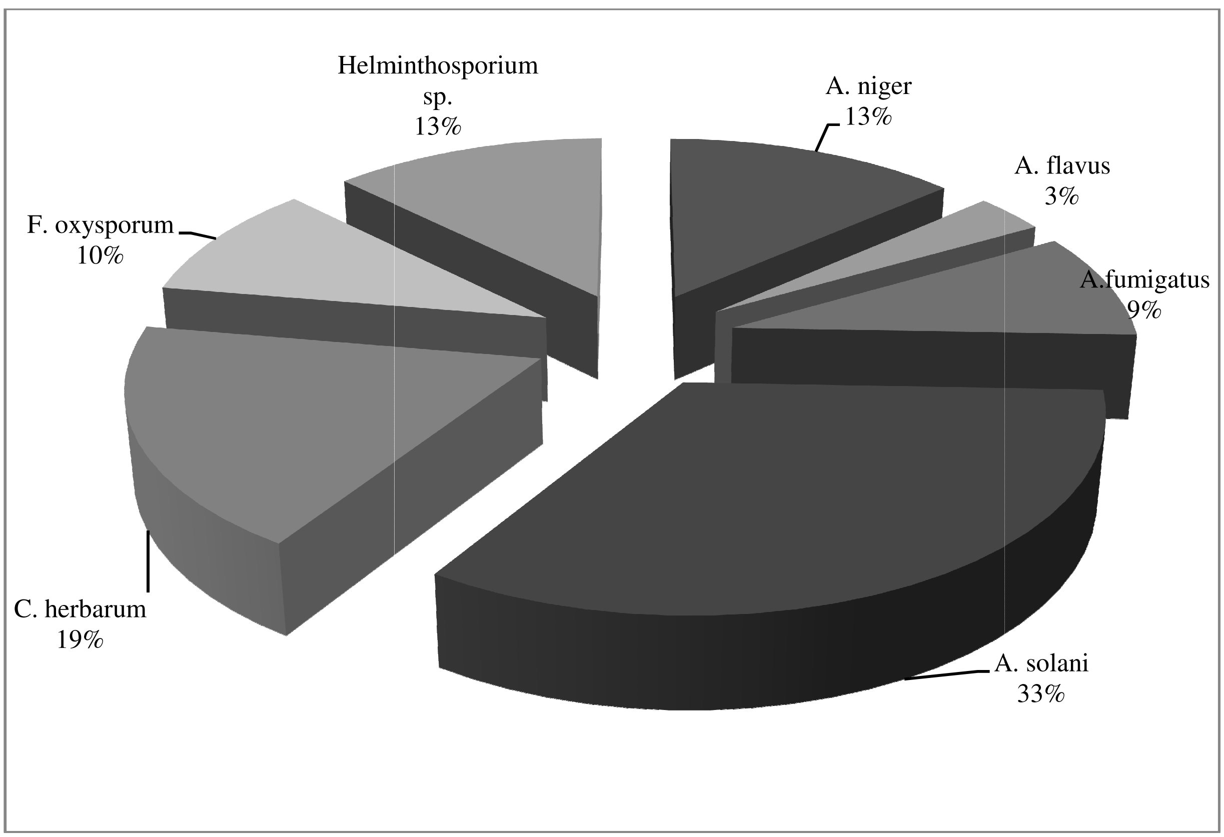

Figure-3: Distribution pattern of various fungal species in winter.

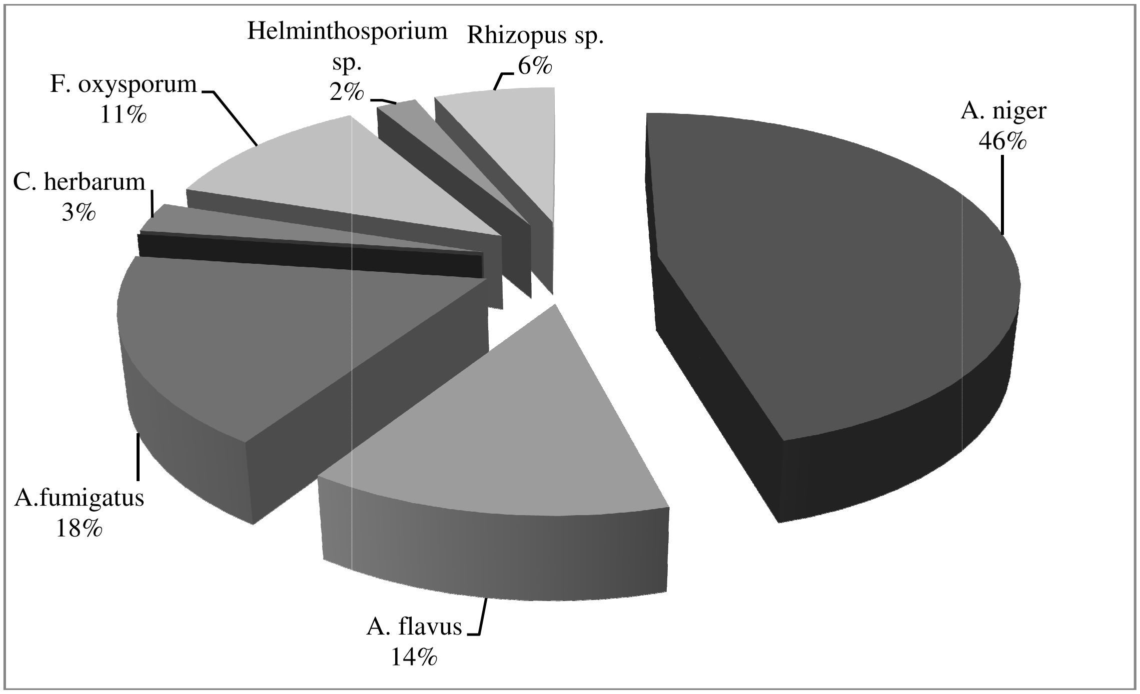

Figure-4: Distribution pattern of various fungal species in summer.

Table-3: ANOVA for Fungi.

Source of Variation	SS	Df	MS	F	P-value	F crit
Between months	3056.75	11	277.87	14.561	4.60295E-08	2.22
Within months	458	24	19.08			
Total	3514.75	35				

Discussion: In past years, fungal infections of hospital origin have been represented by diversity of fungal isolates, their increased incidence and greater severity. The concentrations of total airborne fungi in the hospital outdoor patient room within a period of one year were ranged from 26.66–50.83 cfu/m^3 which was comparable to studies of Ekhaise *et al.*[15] and Qudiesat *et al.*[16] at different hospital rooms. For most individuals breathing ambient concentrations of airborne fungi do not pose any adverse effects, due to healthy immune system. However, hospitalized patients with suppressed immune system are more susceptible to infections from these fungi which can grow at body temperature. In our research, though fungal concentration was low, their mere presence in the hospital environment is of great concern.

Fungal flora of the air of the examined outdoor patient room was dominated by *Aspergillus* sp. which constituted 42.65% of total fungal count, it corresponds with the results of some previous researchers[18-19]. Among *Aspergillus* sp., *A. niger* was most common and isolated throughout the year which is also in agreement with the results of Panagopoulou *et al.*[20] who found 25.9% of *A. niger* from department with high risk patients.

The incidence of infection caused by *Aspergillus* sp. has risen in recent years. Hospital mortality caused by invasive pulmonary aspergillosis have been reported 8-30% in kidney transplant patients, 13-80% in leukemia patients and as high as 95% in bone marrow transplant patient[17]. Apart from this, *Aspergillus* have also been associated with nosocomial infections in immuno-compromised patients, allergic alveolitis, asthma and possibly mycotoxicoses[21]. Concentrations of *Aspergillus* spores above 50 cfu/m^3 were found to be associated with a higher prevalence of the sick building syndrome symptoms in exposed people of Swedish dwellings[22]. Other fungi such as *Fusarium* sp. and *Rhizopus* sp. also serve as potential sources of allergens and toxins and thus a respiratory risk[23].

In present research, fungi showed a highly significant seasonal variation with a very distinct peak in December. In some previous studies Herman[24] and Augustowska and Dutkiewicz[15] also noted the highest count of airborne fungi inside the hospital in early December and November respectively. The study also showed seasonal fluctuation in different type of fungus. *Aspergillus sp.* showed highest count in summer, which is in accordance with the fact that its spores are generally well adapted to survive in the absence of water and nutrient in the environment[25]. *Cladosporium* sp. prevailed during monsoon period which may be due to favorable environment such as high humidity and presence of plenty of organic food. In winter *Alternaria* sp. were found in higher counts, may be due to production of dry conidia in chains and greater dispersal of dry powdery spores in air by this species[26].

Both *Cladosporium* and *Alternaria* sp. are saprophytes or parasites on plants and are associated with various respiratory diseases[27]. Azab and his colleagues found *Alternaria* sp. as a major allergen that has a significant role in the induction of asthma[28]. In another study performed in Asthma Center in Brooklyn, New York, USA, a strong positive association was found between *Cladosporium* sensitivity and asthma severity[29].

Conclusion

In present study, 8 fungal species were isolated from a hospital outdoor patient room. *Aspergillus* sp. dominated among the fungus and seasonal variation in different fungi was also observed. Though obtained fungal concentration in the examined room was low but presence of some genera such as *Aspergillus, Alternaria* and *Cladosporium* pose a great threat to patients as well as hospital staff. Thus there is a need for developing standards for indoor air quality related to fungal pollution in hospitals and other health care settings.

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