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AEROMYCOLOGICAL INDOOR ENVIRONMENTAL STUDY OF K.T.S. GENERAL HOSPITAL GONDIA, (MAHARASHTRA) INDIA

S.G. KUKREJA [1] NITIN B. KATRE [2] A.J. MUNGOLE*[3]

[1]Adarsh College Desaiganj (Wadsa) (MS) India – 441206
[2, * 3] IHlR & SS, Nevjabai Hitakarini College Bramhapuri (MS) India – 441206

Corresponding author email: aru.mungole@gmail.com

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ABSTRACT

Fungal spores in indoor air may come from outdoor by ventilation or they may originate within (Kukreja et. al., 2014). When these spores get favorable conditions, they proliferate and cause the deterioration. An aeromycological study verifies the presence and quantifies the concentration of fungal propagules in the air. It is very important in the hospital setting because of the increasing numbers of immune suppressed and severely ill patients (Waghare et al., 2016) .The objective of this study was to determine the concentration of fungi in the air of the different sections like Outdoor Patient Department (O.P.D) Operation Theater (O.T.) and General Ward Section, of K.T.S General Hospital Gondia. The total 1349 colonies were trapped from feb.2023 to Jan 2024 by exposure petriplate method. Out of 1349 colonies, total 508 colonies found in O.P.D, 481 colonies found in General ward and 360 colonies found in Operation Theater of hospital. The maximum fungal spores were recorded in O.P.D. section followed by general ward while minimum fungal spores seen in Operation Theater of K.T.S General hospital Gondia. Total 6990 CFUs/m^3 are observed by Hi- media air sampler method. There was 2575 CFU_s/m^3 found in O.P.D. section while 2370 CFU_s/m^3 in General Ward and 2045 CFU_s/m^3 O.T.section. Fungi found in indoor environment of hospital are Aspergillus, Cercospora, Mucor, Penicillium, Rhizoctina, Cladosporium, Rhizopus and Alternaria.

INTRODUCTION

Aeromycology is the branch of aerobiology that studies the dispersion of spores and other fungal elements in indoor and outdoor air, the changes in their concentrations, and the factors that affect those changes (Badillo 2012). Fungal spores enter hospitals through ventilation systems and fungi develop on multiple surfaces, releasing more spores. (Pasanen et al., 1992).The number of spores in indoor air varies depending on climate, weather, air currents, humidity, temperature, time of the day, type and maintenance of ventilation systems, age of the buildings, movement of people, cleaning etc. According to Natural Resources Institute (NRI, 1990) Aerobiology is the study of the movement and dispersal of living or nonliving material through the atmosphere but now included the movement of fungal spores and pollen through atmosphere in relation to plant and human health Rita (Shabnam Luka; Kavita Sharm; Preeti Tiwari; 2014).

The occurrence of fungal spores in the atmospheres has directly affected by climatic factors and causes effect on human, animals and plants. The air we breathe contents fungal spores causes respiratory diseases. Fungal spores are also responsible for causing human allergies such as asthma, seasonal cold, urinary problems, skin diseases etc. (Nagdeve, 2020; Waghare, 2014; Kukreja & Sawaji, 2006). Now a day's fungal allergy is worldwide problem and the prevalence of mold allergy might be high (BhattacharyaK, Raha S, Majumdar M.R. 2001). Because of these reason the concentration of fungal spores should be maintain below certain level that is purposes of the present work in K.T.S. General Hospital Gondia.

Fungi have a highly evolved libration mechanism, next to angiosperm and the numbers of spore liberation is very high. The spore being light and small in size remains suspended in the air over and extended period of time (Nunes Z.G, Martins AS, Altoe AL, et al.2005). The number and types of spores vary with the time of day, weather, season, geographic location and presence of local spore sources.

Aerobiological survey of intramural or extramural environments is most important aspects in aero-microbiology. Microorganism like moulds and yeast are very common in air so fungal spores contribute to a major portion of air spore. Aerobiological survey is of great interest for microbiologist and also has greater impact on clinicians and allergic patients (Bush, R.K. & Portnoy, J.M. 2001).

MATERIAL AND METHOD

Study area:-

The investigation was performed in K.T.S. General Hospital Gondia, dist. Gondia (Maharashtra) India located at Latitude – 21.457205° and Longitude – 80.195671°

Sampling Method -

Air samples were collected from the three section of hospital viz. Outdoor Patient Department (O.P.D) Operation Theater (O.T.) and General Ward by the two methods such as exposure petriplate method and Hi- media Air sampler Mark-II method. The aerial survey of indoor fungal spores collected at K.T.S. General Hospital Gondia for one year from Feb. 2023 to Jan 2024. Samples were collected at 15 days intervals with the help of Petriplate method containing CZapek's Dox Agar (CDA) fortified with streptomycin, two times in a month. The petriplates were kept at five feet from the ground level exposed for 10-10-12 minutes and then petriplates were properly sealed, marked and incubated at room temperature. After 3-7 days Colonies were Observed, Counted and sub cultured for

identification (Nagdeve, 2020; Waghare,2014; Kukreja & Sawaji,2006).

Air Samples were collected at 15 days intervals with the help of Hi Air sampler mark II. Hi media laboratories, India. Rose Bengal Agar Strips is used in the Sampler and sampler is operated for five minutes. Fungal Concentration is expressed as a number of Colonies forming units per cubic meter air i.e. CFU_s/m^3. After the sampling Rose Bengal Strip removed from the sampler, it is sealed and brought to laboratory for incubation at room temperature and observed the growth of fungal colonies.

CFU_s/m^3 is calculated as follows.

$$CFU_s/m^3 = \frac{\text{Colonies on agar strip} \times 25}{\text{Sampling Time in Minute}}$$

RESULT AND DISCUSSION

The micro flora of any habitat varies with host type environmental condition & relations among them. Thus the diversity of microflora differs from time to time & place to place.

Aeromycological indoor environmental study of K.T.S. general hospital Gondia Maharashtra India data was conducted from Feb. 2023 to Jan. 2024. For this study three section of hospital such as Outpatient Department, general ward and operation theater section were selected for indoor air sample were collected for one year at fortnightly by exposure petriplate method and Hi-media Air sampler Mark-II method.

The total number of colonies trapped by **exposure petriplate method** in indoor environment of K.T.S. General Hospital Gondia is 1349. Out of total (1349 colonies), the maximum (508 colonies) found in O.P.D. section followed by General ward (481 colonies) and minimum (360 colonies) trapped in Operation Theater of hospital (Table 2).

Fungal spore exhibit seasonal variation. The rainy season have highest fungal spore concentration (42.25 %) followed by winter season (30.91%) while summer season have low concentration (26.83%) by petriplate method.

Fungal spores also show monthly variation. The maximum fungal spore concentration was found in month of August (13.12%) followed by September (11.26%), July (9.56%), January (8.67%), June (8.30%), October (8.00%) February (7.78%) March (7.48%), November (7.19%), December (7.04%), April (6.81%) and minimum in month of May (4.74%) .

The total number of colonies trapped by **Hi-media Air sampler Mark-II method** in indoor environment of K.T.S. General Hospital Gondia is total 6990 CFU_s/m^3 (Table 3)..

Out of total (6990 CFU_s/m^3) maximum (2575 CFU_s/m^3) found in O.P.D. followed by General ward section (2370 CFU_s/m^3) and in O.T. section (2045 CFU_s/m^3).

Fungal spore exhibit seasonal variation. The rainy season have highest fungal spore concentration (42.20%) followed by winter season (32.40%) while summer season have minimum concentration (26.39%) by Hi-media Air sampler Mark-II method.

Fungal spores also shows monthly variation. The maximum fungal spore concentration was found in month of August (12.51%) followed by September (11.23%), July (9.15%), February (8.58%), June (8.29%), January (8.22%), October (8.08%), December (8.08%), November 7(.01%), March (7.36%), April (5.79%) and minimum in month of May (4.64%).Maximum concentration was found in O.P.D. section followed by concentration was found in General ward section. The minimum concentration was found in O.T. section by both methods.

Monthly variation of fungal spore concentration shows similar result by both methods fungal spore concentration was highest in month of August with high humidity and average temperature while lowest concentration was found in month of May having low humidity and high temperature. (Nagdeve, 2020; Waghare,2014; Kukreja & Sawaji,2006). Some of the genera found in the hospital indoor environment are following species. Aspergillus, Cercospora, Mucor, Penicillium, Rhizoctina, Cladosporium, Rhizopus and Alternaria

Table 1 Metrological Data of district Gondia (2023-24)
Source - Regional Meteorological Center Nagpur.

Month	Temperature			Humidity (%)		Humidity Avg. (%)	Precipitation (mm)
	Min.(°C)	Max.(°C)	Avg.	Min.	Max.		
February- 2023	9	37	23.90	30	89	30	9.4
March- 2023	15	39	26.85	22	79	34	9.1
April -2023	19	42	29.25	20	72	28	7.6
May -2023	19	44	32.00	16	65	26	16.5
June- 2023	22	44	32.57	30	96	55	190.5
July- 2023	22	37	28.37	58	97	83	232.4
August-2023	22	35	27.71	53	98	85	221
September2023	21	37	27.46	49	94	80	137.2
October-2023	16	36	26.64	41	81	65	36.6
November-2023	15	34	23.90	36	75	57	11.9
December-2023	9	32	27.85	34	72	53	5.9
January -2024	8	32	28.55	50	85	50	5.9
Total							**884**

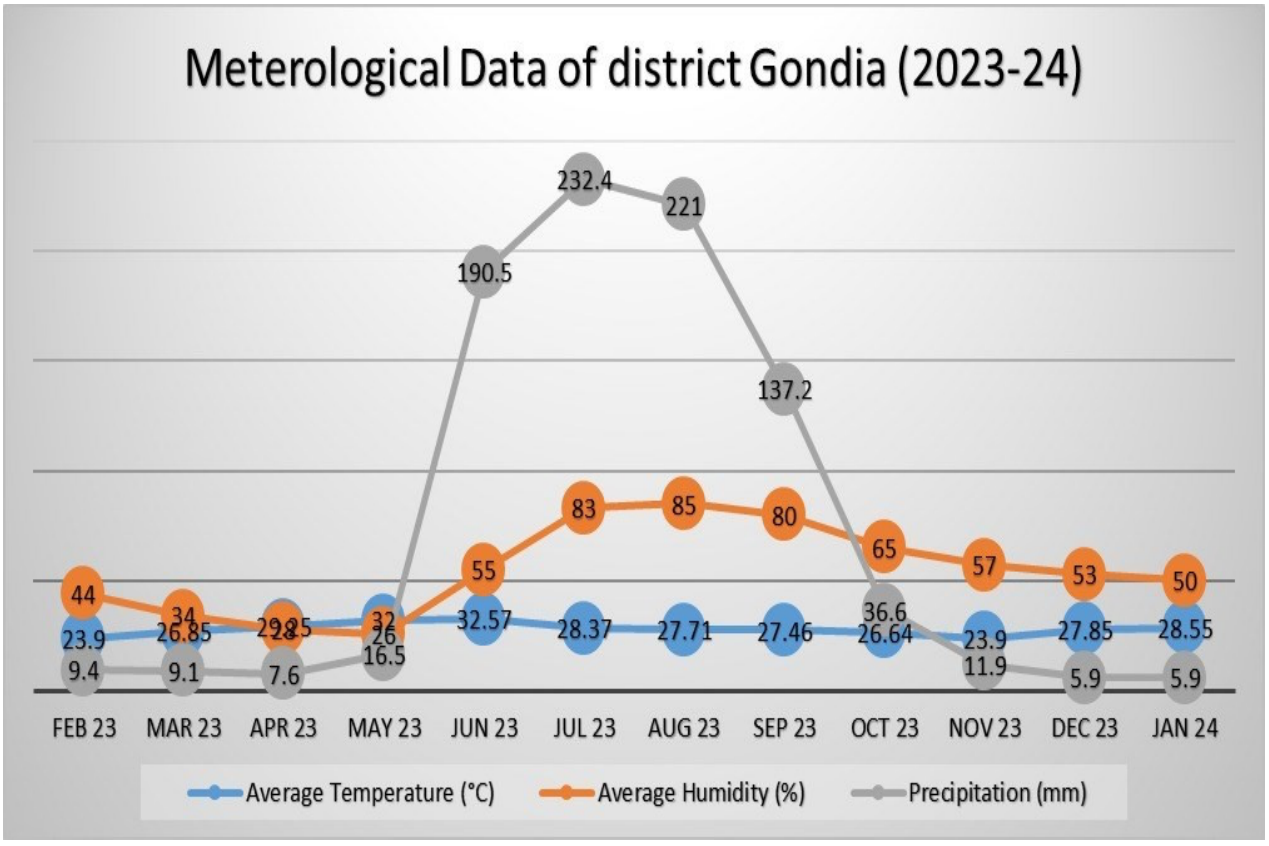

Figure A. Meteorological Data

Table 2. Exposure Petriplate Method: Fungal spore concentration observed from February 2023 to January 2024 in three different section of K.T.S. General Hospital Gondia.

Seasons	Month	Total no. of colonies in O.P.D	Total no. of colonies in General Ward	Total No. of colonies in O.T.	Total Fortnightly	Total in monthly	Monthly Percentage	Seasonal Percentage (%)
Summer Season 2023	Feb. 2023	20	17	13	50	105	7.78	26.83
		21	19	15	55			
	March 2023	18	20	14	52	101	7.48	
		19	18	12	49			
	April 2023	16	17	11	44	92	6.81	
		18	16	14	48			
	May 2023	13	10	08	31	64	4.74	
		14	12	07	33			
Rainy Season 2023	June 2023	19	20	15	54	112	8.30	42.25
		18	22	18	58			
	July 2023	22	24	20	66	129	9.56	
		24	22	17	63			
	Aug. 2023	33	32	27	92	177	13.12	
		30	31	24	85			
	Sept. 2023	29	28	22	79	152	11.26	
		28	26	19	73			
	Oct.	25	20	14	59	108	8.00	

Winter Season 2023-24	2023	19	18	12	49			30.91
	Nov. 2023	20	17	13	50	97	7.19	
		19	18	10	47			
	Dec. 2023	19	17	13	49	95	7.04	
		21	15	10	46			
	Jan. 2024	22	20	15	57	117	8.67	
		21	22	17	60			
	Total	**508**	**481**	**360**	**1349**	**1349**		

Table 3. Hi - Media air sampler method

Fungal spore concentration observed from February 2023 to January 2024 in three different section of K.T.S. General Hospital Gondia.

Seasons	Month	Total no. of CFU_s/m^3 in O.P.D	Total no. of CFU_s/m^3 in General Ward	Total no. of CFU_s/m^3 in O.T.	Total Fortnightly	Total in monthly	Monthly Percentage	Seasonal Percentage
Summer Season 2023	Feb. 2023	110	105	95	310	600	8.58	26.39
		105	100	85	290			
	March 2023	95	90	80	265	515	7.36	
		90	85	75	250			
	April 2023	75	70	65	210	405	5.79	
		70	65	60	195			
	May 2023	65	55	50	170	325	4.64	
		60	50	45	155			
Rainy Season 2023	June 2023	105	90	80	275	580	8.29	41.20
		115	105	85	305			
	July 2023	120	110	95	325	640	9.15	
		125	100	90	315			
	Aug. 2023	160	145	135	440	875	12.51	
		155	150	130	435			
	Sept. 2023	150	145	115	410	785	11.23	
		140	130	105	375			
Winter Season 2023-24	Oct. 2023	100	105	90	295	565	8.08	32.40
		95	95	80	270			
	Nov. 2023	110	90	80	280	560	8.01	
		100	95	85	280			
	Dec. 2023	110	100	75	285	565	8.08	
		105	90	85	280			
	Jan. 2024	115	105	90	310	575	8.22	
		100	95	70	265			
	Total	**2575**	**2370**	**2045**	**6990**	**6990**		

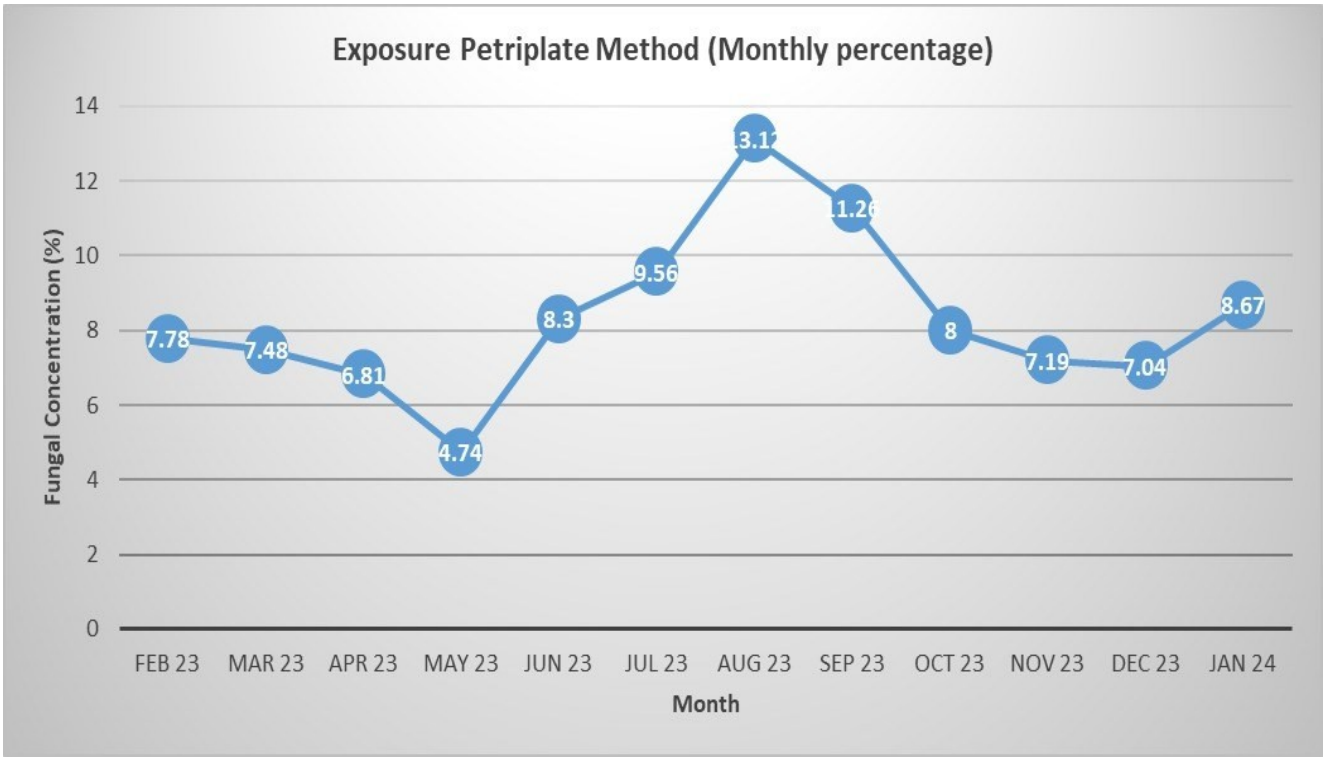

Figure B: Monthly variation of fungal spore Concentration by exposure petriplate method in K.T.S. General Hospital Gondia

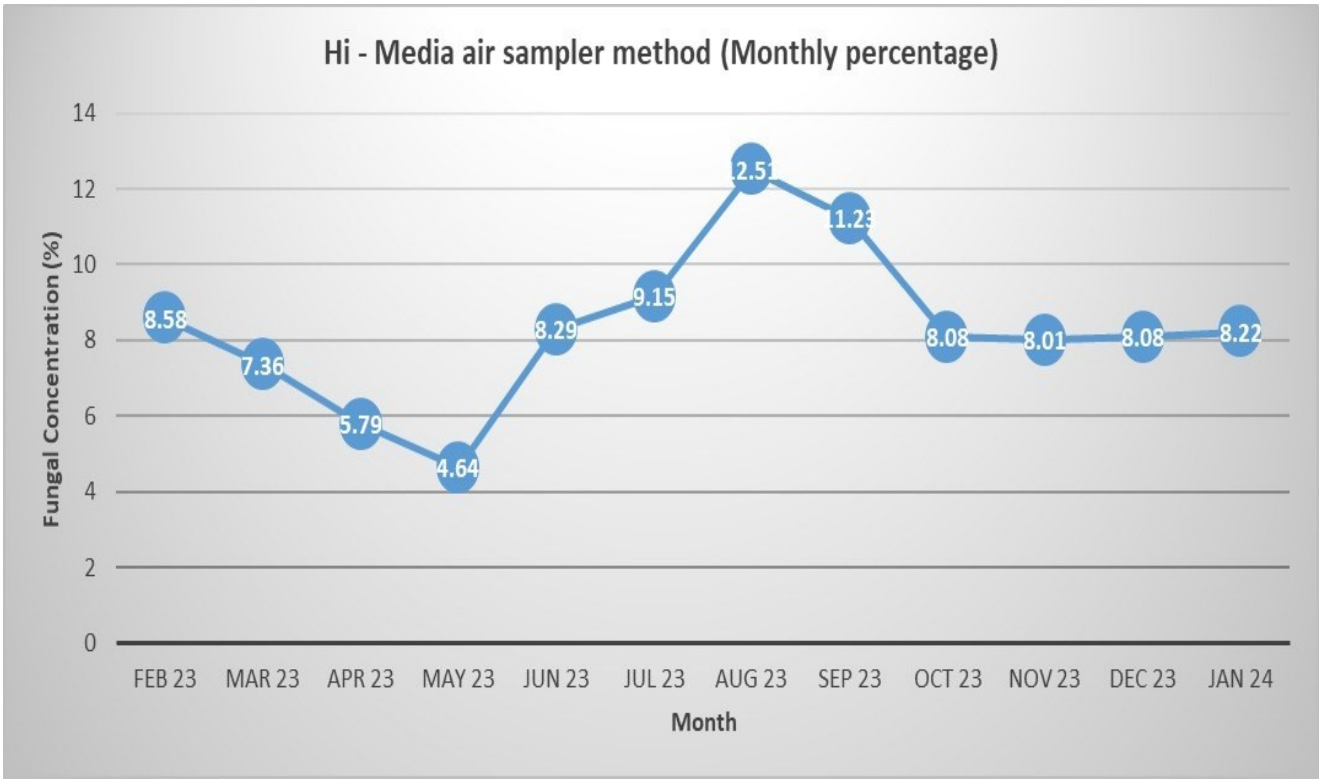

Figure C. Monthly variation of fungal spore Concentration by Hi- media air sampler method in K.T.S. General Hospital Gondia

CONCLUSION

Highest concentration was found in Outpatient Department (O.P.D.) while minimum concentration was found in Operation Theater (O.T.). The minimum concentration (68 and 385 $CFU_s/m^{3)}$ found in month of May having less humidity with maximum temperature. (Table.2&3)Fungal spore concentration varied seasonally as well as monthly according to meteorological parameter.Spore concentration exhibits seasonal variation it was maximum in rainy season followed by winter and minimum in summer.

The current study revealed that monthly variation exhibited the maximum fungal spore concentration in a month of August by both methods having more humidity and

moderate temperature and minimum in month of may where low humidity and high temperature (Table.1). Humidity more than 80% and moderate temperature between 25°C to 30°C provide best environment for the fungal growth.The precipitation was more from June to September and fungal spore concentration was high during that period. There were appreciable increases in indoor fungal spore concentration of K.T.S. General Hospital Gondia **(Figure.A& B).** Fungi found in indoor environment of hospital are *Aspergillus, Cercospora, Mucor, Penicillium, Rhizoctina, Cladosporium, Rhizopu and Alternaria.*

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