Pakistan Journal of Social Sciences 7 (2): 151-154, 2010
ISSN: 1683-8831

Common Mould Related Health Problems Associated with People Living in Houses with Moisture Problem

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Abstract: Seven live-in houses situated in two different types of housing conditions in Port Harcourt, Rivers State of Nigeria and their occupants were used in identifying the common mould related health problems associated with people living in houses with moisture problem. Five of the houses were identified with having moisture problem as a result of constant flooding from rainfall, poor or total lack of drainages and leakages from roofs, sinks, pipes and walls while the other two houses were basically moisture problem free. Air samples from all the rooms of the study sites were collected, processed and the presence of moulds confirmed in them. Eighty human specimens made up of hair, skin scrapes, nails and sputum from the occupants were processed with 20% KOH in a wet mount preparation and cultured on sabouraud dextrose agar incorporated with chloramphenicol. The percentage occurrence of mould related health problems encountered in this study were Tinea cruris (10%), Tinea capitis (20%), Tinea corporis (20%), Tinea unguium (15%), Tinea pedis (10%), Tinea barbae (5%) and persistent sneezing, headache and cough (20%). Tinea capitis, corporis and persistent sneezing headache and cough which accounted for 20% each were found to be the most common mould related health problems associated with people living in houses with moisture problem.

Key words: Moulds, moisture problem, health, living houses, Tinea, Port Harcourt

INTRODUCTION

Mould is part of the fungi kingdom, a realm shared with mushrooms, yeast and mildews. They are microscopic organisms that may be found throughout the natural environment. Moulds can grow on cloth, carpets, leather, wood, sheet rock, insulation (and on human foods) when moist conditions exist (Gravesen *et al*., 1999). Due to the nature of moulds to grow in moist or wet indoor environments, it is possible for people to become exposed to moulds and their products, either by direct contact on surfaces or through the air if the mould spores, fragments or products are aerosolized. Mould spores or fragments that become airborne can expose people indoors through inhalation or skin contact. The term sick house or sick-building syndrome is a house with a serious air quality problem.

The area can be described as sick, mainly because people develop symptoms of illness such as headaches, watery eyes, nausea, skin disorders and fatigue when they spend considerable time where there is a build-up of air pollutants from household products, building materials, formaldehyde and/or respirable particles. Most sick houses are usually houses with a serious moisture problem. This moisture in turn plays an important role in promoting the growth and spread of mould. Water accumulation in indoor environments can lead to mould growth (and other environmental problems) which has been associated with human health effects (Environmental and Workplace Health, 2004; Institute of Medicine, 2004; Mazur and Kim, 2006; Seltzer and Fedoruk, 2007; Storey *et al*., 2004). There has been strong evidence that significant disease can result from dampness and fungi in the home or work place (Dales *et al*., 1991; Brunekreef *et al*., 1989). The environment often has a role in the development and progression of disease (Menzies and Bourbeau, 1997) because the recognition of environmentally induced illness provides the opportunity to prevent the disease progression. Since there has been virtually little or no information relating indoor environments with moisture problem to the health problems of the occupants in any part of Nigeria this study is therefore aimed at identifying these mould related health problems associated with people living in houses with moisture problem in Rivers State of Nigeria.

MATERIALS AND METHODS

A total of seven live-in houses were enlisted along with their occupants for this study. The sample collection sites were within the Port Harcourt metropolis of Rivers

State, Nigeria. They were of two categories; Category (A) was the area identified with moisture problem (Sites 1-4), while Category (B) was the area identified to not have any form of moisture problem (Sites 5-7) and this is to act as the control sites for this study. Description of these sites is in Table 1.

Air samples were collected from all the sites once every month for an entire year, while human samples (hair, skin scraps sputum and nails) from the medical examination of the occupants residing at each of the sites was collected once every two months as the occupants went for a pre-booked medical checkup and also whenever they fell sick and reported to the clinician.

Sample collection: Air samples were collected as follows; freshly prepared sabouraud dextrose agar with chloramphenicol incorporated was left to stand open in the various rooms of the house for 1 h, then covered, sealed with masking tape, labeled and taken to the laboratory for incubation at room temperature for 3-4 weeks (Malloch, 1997).

Records of flooding incidences resulting from rain fall, poor or total lack of proper drainages and leakages from ceiling, pipes, sinks, bath tubs and walls were also taken at all the sites every month alongside the air sampling.

Samples from the house occupants such as hair, skin scrapings and nails were collected from infected sites of the individuals who reported sick to the clinician. This was done by soaking cotton wool in 70% alcohol and swabbing the infected site to disinfect it. Skin scales, nails or hair was scraped using a sterile scalpel blade into clean paper. The sputum was collected into a sterile universal bottle. All specimens were labeled properly (code name, age, sex, type and site of sample collection).

Sample processing: A daily inspection of the incubated air samples in sabouraud dextrose agar was made and the resultant culture was processed by:

- Observing the colonial morphology of the growths such as the colour, texture, margins, shape etc.
- Tease mount method (Murray *et al*., 2005)
    - A drop of lactophenol cotton blue mounting fluid was placed on a clean glass slide
    - A portion of mycelium is transferred to the lactophenol cotton blue stain and teased out using a 22-gauge nichrome needle to separate the filaments
    - A cover slip is placed over the preparation and gentle pressure applied
    - This was examined using 10 and 40 objectives of the microscope

Table 1: Sample sites and their description

Site	Description	No. of occupants
1	A two room apartment situated in the middle of a long horizontal building. 4.0 by 4.0 ft in measurement with headroom of 2.6 m. One window and a door in each room. Poor drainage. Constant flooding when it rains	7 people
2	A three room apartment situated in a compound that consists of two long parallel buildings that face each other. 4.0 by 5.0 ft in measurement with headroom of 2.8 m. Each room has one back window and a door that serves as the entrance. Poor drainage. Constant flooding when it rains	8 people
3	A one bedroom flat situated in an unplanned clustered settlement. The rooms vary in shape and sizes but all with headroom of 2.4 m. Two windows in the sitting room and one in the bedroom. No drainage. Perpetual flooding when it rains	5 people
4	A two bedroom flat situated in a sand-filled swampy area. Headroom of 2.8 m. One window in each room except the sitting room with three windows. No drainage. Constant flooding when it rains	6 people
5	A one storey building of four bedrooms situated at a Government Reserved Area (GRA). Headroom of 3.8 m. Sufficient windows and doors properly situated in all the rooms. Air conditioned rooms and proper drainage system	6 people
6	A four bedroom flat situated at a well planned township area. Headroom of 3.0 m. Each room is properly ventilated because of sufficient and properly situated windows and doors. All rooms except the kitchen, bathroom and store all have ceiling fans. Proper drainage system	6 people
7	A three bedroom flat at an oil company residential quarters. Headroom of 3.0 m and each room is properly ventilated with sufficient and properly situated windows and doors. Sitting room is air conditioned while other rooms have ceiling fans. Proper drainage system	5 people

For the human samples, (the hair and nails were first macerated) an initial wet mount preparation in 20% KOH (Potassium Hydroxide) was made for direct microscopy as described by Hainer (2003) for each specimen and was carefully examined under 10 and 40 power objective for the presence of hyphae and/or arthroconidia. Afterwards the human samples were seeded into sabouraud dextrose agar containing chloramphenicol at 16 $\mu g\ mL^{-1}$ using a straight inoculating wire and incubated at room temperature for 3-4 weeks.

A direct examination was also done for the sputum, where the most purulent part of the sample was selected and a pinch of N-acetyl-L-cystine was added. A drop of this mixture was put on a clean glass slide, a cover slip placed over it and it was examined with 10 and 40. It was cultured by inoculating on the surface of Brain Heart

Infusion agar (BHI) containing chloramphenicol at 16 µg mL^{-1} and incubated at 30°C. All fungal cultures were identified using the same procedure as used for the air samples.

RESULTS AND DISCUSSION

The air sampling from all the sites of study yielded mould growths as shown in Table 2 with the most occurring moulds being *Penicillium* sp., *T. rubrum* and *Mucor* sp.

Out of the eighty human samples collected, hair samples had the highest frequency of occurrence of 30, while nails had the least occurrence of 7 (Table 3). Occupants of Sites 1-4 exhibited more clinical symptoms than occupants of Sites 5-7 (Table 4), just as higher relative humidity values, more flooding incidences and more leakage sites were recorded at Sites 1-4 compared to Sites 5-7.

Table 5 shows that Tinea Corporis, Tinea Capitis and sneezing, Headache and cough had the highest percentage of 20% each.

The results obtained from this study revealed that Sites 1-4 had a predominantly hot atmosphere and relative humidity >60% throughout the one year of study.

This could be attributed to the overcrowding of the houses with both people and furniture beyond the original carrying capacity of thehouses as described in Table 1 and the lack of proper ventilation due to insufficient windows and doors.

The high frequency of flooding and leakages also recorded could be attributed to their locations at swampy areas, poor drainage systems, poor layout and low structural integrity of the houses which even made repairs difficult. Similar reports were made by Pasanen (2000). This is a complete opposite to the results obtained from Sites 5-7 with moderate temperature, lower humidity levels, no flooding and insignificant leakages. This is clearly a result of better housing and environmental condition.

The atmospheric condition (temperature and humidity) most favorable for the growth and proliferation of moulds are a temperature between 10-32°C with its optimum temperature at 23°C (which incidentally is also the temperature which humans prefer) and a humidity of at least 60%.

The earlier criteria were fully met in Sites 1-4 which resulted in the heavy growth and isolation of more moulds in these sites than in Sites 5-7 which yielded fewer moulds. This agrees with the findings of the Environmental and Occupational Health (2003) on Exposure to Environmental hazards; Indoor moulds.

This study also revealed that Sites 1-4 had more cases of infection with all cases positive for moulds than Sites 5-7 (Table 4).

This could be as a result of the conducive condition (consistent moisture) for the growth of moulds found in Sites 1-4 and the overcrowding in them that facilitated the spread of the infections.

Site 5 and 7 had one infection case each and could have been as a result of acquired infection from the saloons, where they went for pedicure and barbing/shaving.

The high percentage occurrence of Tinea corporis (20%) and Tinea capitis (20%) could be attributed to the high number of clinically infected hair and skin samples collected during the study and also to the high frequency of isolation of *T. mentagrophytes* and *M. audouinii* (Table 4) which are the main causative agents for Tinea corporis and Tinea capitis, respectively. These dermatophytes were found interchangeably on the skin and hair-scalp and could be a result of human to human infection, sharing of towels, combs, pillows and clothing items as is the case in large families.

Table 2: Environmental parameters and types of mould isolated from the air samples of the study sites within the year of study

Study sites	Ave Air temperature (°C)	Ave relative humidity (%)	Total no. of leakages	Total number of flooding incidences	Types of mould isolated from each study site
1	31.1	80.2	79	54	A. fumigatus, *Rhizopus* sp., *Cladosporium* sp., *Penicillium* sp., *T rubrum, T. mentagrophytes, M. canis Mucor* sp., *M. audouinii, Exophiala* sp., *Fusarium solani, M ferrugineum, A flavus, T.tonsurans Epidermophyton floccosum*
2	30.9	78.6	76	54	All isolates as in site 1 and addition of *A. niger*
3	30.4	76	29	69	All isolates as in site 1 with the addition of sporotrix schenckii and exclusion of *A. flavus*
4	29.6	67.6	34	76	*Cladosporium* sp., *Rhizopus* sp., *Penicillium* sp., *T. mentagrophytes, M. canis, Mucor* sp., *M. audouinii, A. fumigatus, M. ferrugineum, T. rubrum.*
5	29.5	43.9	1	0	*Penicillium* sp., *T. rubrum, Mucor* sp.
6	29.4	42.6	0	0	*Penicillium* sp., *T. rubrum, Mucor* sp.
7	29.5	40.4	1	0	*Penicillium* sp., *T. rubrum, Mucor* sp.

Table 3: Frequency of occurrence of human specimen

Specimen	No. of samples	Percentage of samples
Hair	30	37.5
Skin scrapes	25	31.2
Nail	7	8.80
Sputum	18	22.5
Total	80	100

Table 4: Clinical symptoms and mould isolates from occupants of the study sites

Study site	Clinical symptoms	Mould isolates
1	Sneezing, headaches and cough	*A. flavus*
	Tinea corporis	*T. mentagrophytes, M. audouinii*
	T. capitis	*M. audouinii, M. canis*
	T. unguium	*T. rubrum*
	T. pedis	*T. rubrum, T mentagrophytes*
2	T. capitis	*M. audouinii, T mentagrophytes*
	T. corporis	*A. fumigatus and T mentagrophytes*
	T. cruris	*Epidermophyton floccosum.*
	T. pedis	*T. rubrum, T. mentagrophytes*
3	T. unguium	*T. rubrum*
	T. corporis	*T. mentagrophytes*
	T. capitis	*M. audouinii*
	T. cruris	*Epidermophyton floccosum.*
	Sneezing and cough	*A. flavus*
4	Sneezing, headaches and cough	*A. flavus*
	T. corporis	*T mentagrophytes, M. audouinii*
	T. capitis	*M. audouinii*
5	T. unguium	*T. rubrum*
6	Sneezing and cough	No fungi isolate
7	T. barbae	*M. canis*

Table 5: Percentage occurrence of clinical symptoms

Clinical symptoms	No. of occurrence	Precentage occurrence
Tinea corporis	16	20
Tinea capitis	16	20
Tinea unguium	12	15
Tinea cruris	8	10
Tinea pedis	8	10
Tinea barbae	4	5
Sneezing, headaches and cough	16	20
Total	80	100

CONCLUSION

Moulds can be found everywhere and no geographical area or any group of people is spared by these organisms, no house is also completely free of mould spores as shown by this study. This study has however established that houses with moisture problem will defiantly encourage high proliferation of moulds and this will invariably lead to mould related health problems on its occupants. Mould growth in buildings always occurs because of unaddressed moisture problems. Therefore the moisture problem must be addressed. Living houses must be properly planned and built with prevention of conditions that will encourage mould growth in mind, proper drainage systems must also be provided for.

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