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Indoor Dust Mites and Fungal Spores: A Major Cause of Asthma and Allergic Rhinitis in the Subjects of Punjab (India)

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Abstract

The present survey was carried out to evaluate the sensitivity to dust mites and mold concentrations in the homes of 300 subjects. The home environments of the subjects were evaluated on the basis of questionnaire and by determining the presence of mites and fungi in the dust samples. Based on complete medical history, only 165 subjects of the 300 subjects were selected who were diagnosed with allergic rhinitis and asthma. intradermal skin tests were performed on 165 patients. The patients were divided into 4 groups based on clinical findings 1) Control 2) Allergic rhinitis 3) Asthma 4) Allergic rhinitis and Asthma. Among 165 patients, 35.15% were sensitive to dust mites only, 24.84% were sensitive to dust mites and fungus, 21.81% were sensitive to fungus only, 15.15% were sensitive to allergens other than dust mites and fungus and 3.03% did not show sensitivity to any of the allergen. It was also observed that the patients were sensitive to more than one antigen. The most commonly found house dust mites which cause allergic manifestations are *Dermatophagoides farinae*, *Dermatophagoides pteronyssinus* and *Glycyphagus destructor* and the most common indoor molds are *Penicillium* spp, *Cladosporium* spp and *Mucor* spp.

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The present study aims to identify the major allergens (dust mites and fungal spores) that are responsible for allergic rhinitis and asthma in the population of Punjab. Proper history taking followed by skin tests and fungal culture in specific cases are helpful in the diagnosis of allergic manifestations and their treatment.

***Keywords*:** Asthma; Allergic rhinitis; Fungi; House dust mites; Allergy.

1. Introduction

Mites and fungi are ubiquitous airborne allergens and are important causes of human diseases, especially in the upper and lower respiratory tracts [1]. The concentration of these allergens in the environment varies, depending on various factors including climate, vegetation, and air quality. The outdoor allergens are predominantly constituted by plant pollens and fungal spores. The indoor allergens, on the other hand, are represented by allergens from dust mites, cockroaches and pets. Fungal spores also have been reported from the indoor environment. The concentration and prevalence of the indoor allergens vary substantially and are dependent on moisture content, ventilation, and the presence or absence of pets, carpets, and houseplants [2].

Dust mites feed on organic detritus, like human skin flakes, and flourish in the humid environment. They are a common cause of asthma and other allergies. The mite's gut contains potent digestive enzymes that persist in their feces and induces allergic reactions in human beings. The mite's exoskeleton can also contribute to allergic reactions. Dust mites are found in geographic areas and climates with sufficient humidity to elevate moisture inside buildings and in buildings where humidity levels are raised artificially. Arid areas and high elevations generally do not support dust mite colonies indoors. It is estimated that 84% of US homes have detectable dust mite allergen [3]. House dust mites, in particular *Dermatophagoides pteronyssinus* and *D. farinae* have been shown to play an important role in the parthenogenesis of asthma and atopic diseases [4,5]. Mite allergen level of >2µg/gm of dust (100 mites per gram) is considered as risk level for sensitization and symptoms of asthma [6,7].

Fungal spores are another class of aeroallergens of great importance. When inhaled in large number they cause several health problems viz, nasal and sinus congestion, wheezing, allergic rhinitis, watery and reddened eyes, dry cough, sore throat, throat irritation, Shortness of breath, Skin irritation, aches and pains and possibly fever [8]. Fungal spores are abundant in nature they are lesser than 10 microns in diameter and their deposition into lower airways is common. Fungal sensitization is a significant risk factor for developing asthma in later part of life. Molds grow indoors and outdoors. The two most commonly occurring outdoor molds are *Alternaria* and *Cladosporium*. The most common indoor moulds are *Penicillium, Aspergillus* and *Mucor* that are causing symptoms throughout the year to patients [2].

Damp housing conditions are ideal for the growth of fungi and mites. Growth sites for them in homes may be prolific, including rubbish bags, food storage areas, and upholstery and wall papers together with areas of increased moisture, shower curtains, window moldings and basements [9]. Very few mites can grow if the indoor RH is lower than 45% with an indoor temperature of 22°C. The concentration of dust mite allergens in air and dust varies within and between the homes [3].

Several epidemiological and diagnostic studies have reported an increasing prevalence of allergic reactivity to these allergens [10]. However, the exact prevalence of allergic sensitization is not known, mainly due to lack of standardized allergen extracts and due to overwhelming number of allergenic species that are able to elicit IgE mediated reactions [11].

The present study is aimed to determine the allergen in asthmatic and allergic rhinitis patients and evaluate the current status of biotic indoor air pollution, role of fungi and dust mites as biological contaminants and their impact on human health.

2. Materials and methods

During present study, 300 subjects with allergic manifestation who visited ENT department of Rajindra hospital, Patiala from 2012 to 2015 were considered. The patients were divided into 4 groups based on clinical findings 1) Control 2) Allergic rhinitis 3) Asthma 4) Allergic rhinitis and Asthma. Based on complete medical history, only 165 patients of the 300 subjects were selected for Intradermal skin tests. Based on positivity to skin tests individuals were categorized into 4 groups based on their difference in sensitivity to antigens in different category of respiratory allergies.

- Positive towards Fungi
- Positive towards dust mites
- Positive towards mites and fungi
- Positive towards allergens other than dust mites and fungi

Tests were conducted in the clinical laboratory of Dr. R.S Bedi with commercially available antigens. A 26-gauge tuberculin syringe with ½ inch bevel sterile hypodermic needle was used for injection. Buffer saline was used as negative control and histamine acid phosphate as positive control to see the physiological conditions and general reactivity of the skin. A distance of 4mm was kept between two intradermal skin test sites. The reaction was examined for one hour at an interval of 15-20 minutes.

Samples of fungal spores were collected from the houses located in different areas such as posh area, slums, rural area, from the houses which were without ventilation and houses without proper flooring. For growth of fungal spores, potato dextrose agar plates (PDA) and corn meal agar plates (CMA) were exposed to the indoor environment in each house for 20 minutes. After exposure the plates were sealed and returned to our laboratory on the next day; PDA and CMA were incubated at 25˚C for 3 to 7 days and observed daily. The total amount of airborne fungal spores in the rooms is given as colony-forming unit (cfu)/ plate/ 30min [12]. The slides were got identified from experts in the field after staining with lactophenol blue.

The dust samples were collected for the presence of mites from the house floor by using a vacuum cleaner. The mites were extracted by floatation method [13]. Those mites which appear intact were taken as live whereas incomplete mites were taken as dead.

3. Results

Among 300 subjects, intradermal tests were performed only on 165 subjects whose history was suggestive of allergy. Of these 160 subjects were found to be sensitized for one or more allergens. History of 5 subjects did not give any response to the allergens though their history was suggestive of allergy and taken as control (Table 1, Figure 1).

It has been observed that of the 165 subjects, 58 i.e. 35.15% were sensitive to dust mites only, 41 i.e. 24.84% were sensitive to dust mites and fungus, 36 i.e. 21.81% were sensitive to fungus only, 25 i.e. 15.15% were sensitive to allergens other than dust mites and fungus and 5 i.e. 3.03% did not show sensitivity to any of the allergen. According to our observation maximum numbers of patients were sensitive to dust mites followed by dust mites and fungus and then fungus only (Table 2, Figure 2).

Table 1: Showing number of individuals on whom intradermal skin tests were conducted

No. of Subjects	300
Subjects with intradermal skin tests	165
Subjects give positive response to allergens	160
Subjects give negative response to allergens	05

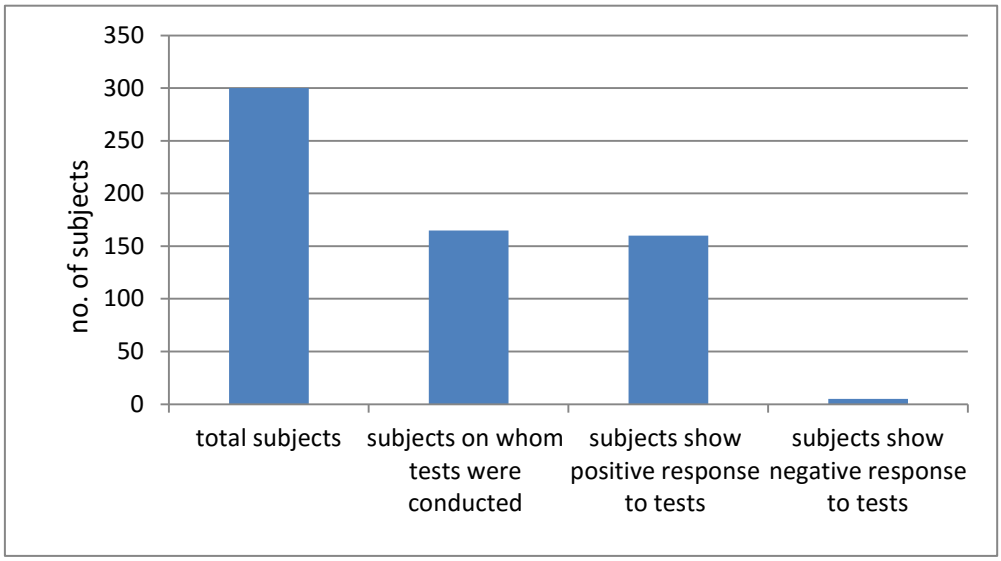

Figure1: Showing total number of Subjects and subjects on whom intradermal skin tests were conducted

Among 80 (50%) asthmatics patients, 25 (15.63%) were sensitive to dust mite allergens, 17 (10.62%) of were sensitive to fungus, 23(14.37%) were sensitive to dust mites and fungi and 15 (9.37%) were sensitive to other allergens. Among 45 (28.12%) allergic rhinitis patients, 12 (7.5%) were sensitive to dust mite allergens, 13(8.13%) of were sensitive to fungus, 15(9.37%) were sensitive to dust mites and fungi and 5 (3.13%) were sensitive to other allergens. Among 33 (20.63%) allergic rhinitis and asthmatic patients, 21 (13.13%) were sensitive to dust mite allergens, 6 (3.75%) of were sensitive to fungus, 3 (1.87%) were sensitive to dust mites

and fungi and 5 (3.13%) were sensitive to other allergens. It has been observed from that patient with asthma showed greater sensitivity than patients with other conditions (Table 2, Figure 3).

Table 2: Prevelence of allergen sensitivity in population of Punjab

Allergens→ Disorders↓	Dust Mites	Fungi	Dust Mites+ Fungi	Other allergens	Total
Asthma	25 (15.63%)	17 (10.62%)	23 (14.37%)	15 (9.37%)	80 (50%)
Allergic Rhinitis	12 (7.5%)	13 (8.13%)	15 (9.37%)	5 (3.13%)	45 (28.12%)
Asthma+ Allergic Rhinitis	21 (13.13%)	6 (3.75%)	3 (1.87%)	5 (3.13%)	35 (21.87%)

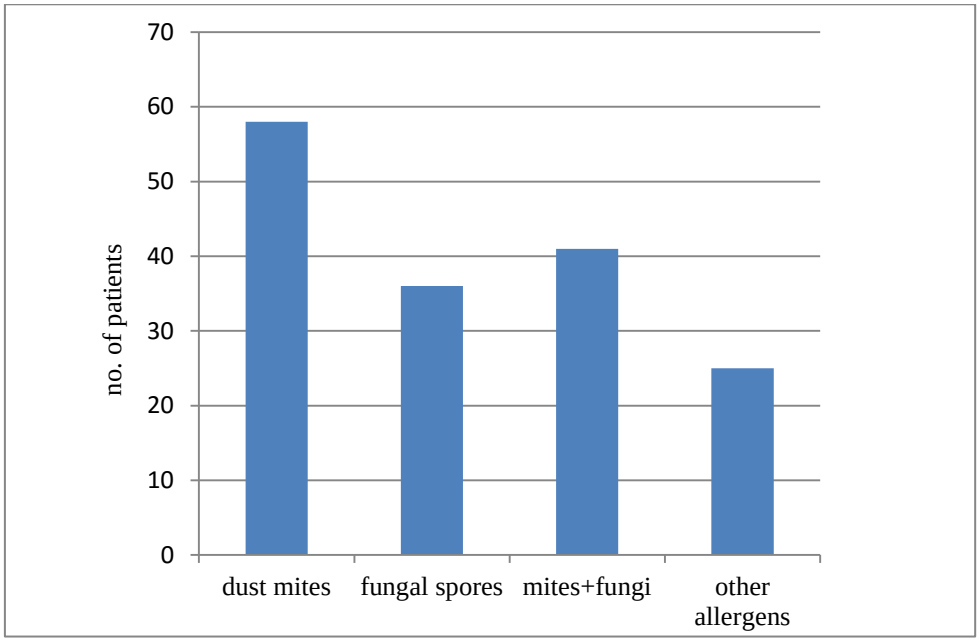

Figure 2: types of allergens to which the patients sensitized

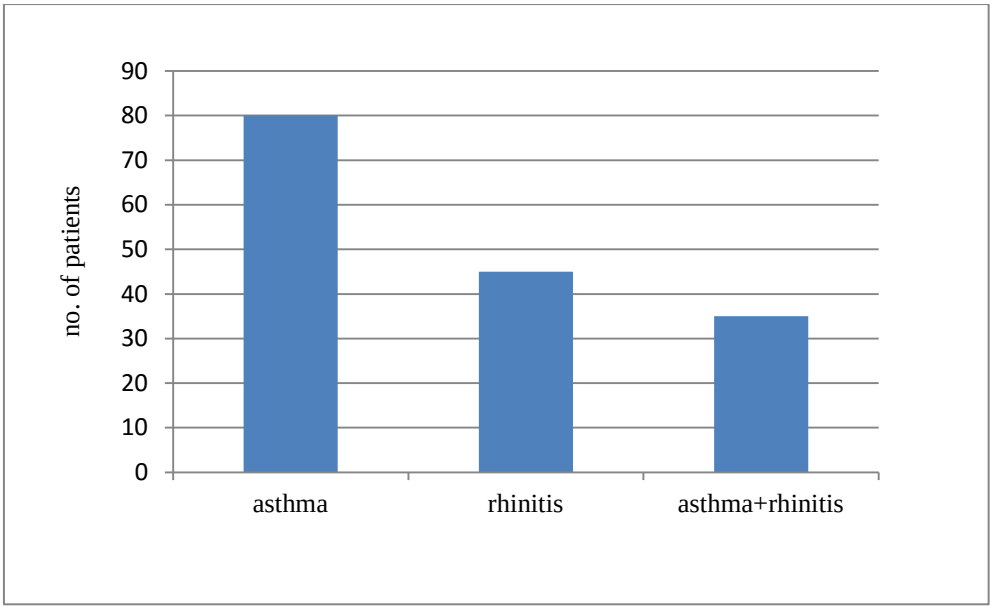

Figure 3: showing allergen sensitivity among individuals with various respiratory allergies.

From dust mites, allergens of *Dermatophagoides farinae, Glycyphagus destructor, Dermatophagoides pteronyssinus, Tyrophagus putrescentiae* and *Acarus siro* were selected. It has been observed that 24.37% were sensitized to *D. farinae*, 16.87% were sensitized to *G. destructor*, 15% were sensitized to *D. pteronyssinus*, 12.5% were sensitized to *T. putrescentiae*, and 5.62% were sensitized to *Acarus siro* (Table 3).

Table 3: Number of individuals sensitized to different type of dust mites.

Dust Mites	Number of individuals
D.farinae	39 (24.37%)
G. desructor	27 (16.87%)
D. pteronyssinus	24 (15%)
T. putrescentiae	20 (12.5%)
A. siro	09 (5.62%)

From the fungi, allergens of *Mucor* spp, *Cladosporium* spp, *Pencillium* spp, *Phoma betae, Rhizopus* spp and *Aspergillus* spp were selected. It has been observed that 15.62% were sensitized to *Mucor* spp, 12.5% were

Table 4: Number of individuals sensitized to different types of fungi.

Fungi	Number of individuals
Mucor	25 (15.62%)
Cladosporium	20 (12.5%)
Penicillium	16 (10%)
Phoma betae	11 (6.87%)
Rhizopus	8 (5%)
Aspergillus	5 (3.12%)

sensitized to *Cladosporium* spp, 10% were sensitized to *Pencillium* spp, 6.87% were sensitized to *Phoma betae*, 5% sensitized to *Rhizopus* spp and 3.12% were sensitized to *Aspergillus* spp (Table 4).

4. Discussion

Indoor level of allergens plays a major role in the development of sensitization and triggering asthmatic attack. Immunoglobulin E specific antigens (allergens) induces type I hypersensitive (allergic) respiratory reaction in sensitized subjects causing rhinitis or asthma [14]. Intradermal skin test was found to be most reliable and available method for allergen sensitivity [15]. Reported sensitivities has ranged from 4% to 92.2%, present studies showed that skin test positivity was 96.97% in properly selected cases. The present studies demonstrate if the case has been selected properly after taking thorough history and preliminary basic investigation of the patient, the incidence of positivity of intradermal skin tests appears to be quite high. It has been observed that of the 165 subjects 58 i.e. 35.15% were sensitive to dust mites only, 41 i.e. 24.84% were sensitive to dust mites and fungus, 36 i.e. 21.81% were sensitive to fungus only, 25 i.e. 15.15% were sensitive to allergens other than dust mites and fungus and 5 i.e. 3.03% did not show sensitivity to any of the allergen.

Dust mites are potentially important source of allergens. The role of mites in causing allergies however remained vaguely defined for a long time till Spieksma and Boezman [16] suggested that the mite *Dermatophagoides pteronyssinus*, which occurs in house dust, was chief cause of its allergenicity. More recent studies by Plattis-Mill and De Weck [17], Plattis-Mill [4], Peat *et al.* [5] and Munir [6] have shown that severity of allergic diseases like allergic rhinitis and asthma varies with exposure to dust mites. Increase in exposure to house dust mites increases the prevalence of current asthma in children who were positive to intradermal skin tests for house dust mites. The present studies confirm these findings. Chang-Young *et al*. [18] found a

relationship between levels of house mite allergen in homes in children with asthma and both daily asthma symptoms and mean daily peak airflow. Mite allergen levels of >2µg/gm of dust (100 mites per gram) is considered as risk level for sensitization and symptoms of asthma and other allergic disorders. Nelson [19] has shown that there is an improvement of asthma symptoms, bronchial responsiveness and pulmonary inflammation when exposure to house dust mites is reduced.

Consentino et al. [20] found that there is a connection between allergic symptoms and presence of high fungal concentrations in the home environments of patients. In present study, *Aspergillus, Alternaria, Cladosporium, Candida, Mucor, Penicillium , Rhizopus* and *Trichoderma* genera were found predominantly. Fungal sensitivity among 165 subjects was observed, *Aspergillus* spp, followed by *Alternaria* spp have been more frequently found to give positive reactions. Among the air borne fungi that spread air spores, important allergens of the world are *Aspergillus* spp, *Cladosporium* spp, *Mucor* spp, *Pencillium* spp, *Rhizopus* spp, *Phoma betae*. They have been reported as the predominant organisms in warm, humid and dry climates [21]. A similar study done by Mezzari *et al*. Reference [22] revealed the prevalence of air borne fungi: *Aspergillus* spp, *Cladosporium* spp, *Pencillium* spp, *Alternaria* spp, *Curvularia* spp and others. Aerobiological survey done in the city of Bangalore (South India) by Aghase and Vidya [23] showed predominance of *Aspergillus* spp,, *Cladosporium* spp, *Penicillium* spp, *Alternaria* spp, *Nigrospora* spp, *Helminthosporium* spp, *Cercospora* spp *and Curvularia* spp. In present study *Nigrospora, Helminthosporium , Cercospore and Curvularia* were all together absent whereas *Aspergillus, Alternaria, Cladosporium, Candida, Mucor , Penicillium , Phoma betae and Rhizopus* genera were found predominantly.

During the present study, it was also observed that majority of samples were characterized by high levels of mites and mould contamination. Mites occurred in all samples (100%) of dust analyzed and similarly the mycoflora was also found in abundance in the homes of allergic subjects. The overall sensitization to mites (36.25%) was higher than fungi (22.5%). These results are in accordance to the results given by Palmas et al. [12]. During skin tests, it was observed that the patients were sensitive to multiple fungal antigens. This could be due to cross reactivity between fungal antigens.

The concentration of mites and moulds depends on some physical environmental factors such as temperature and relative humidity. During the study, it was observed that the conditions of homes like dampness, improper ventilation, humid surroundings all collectively influence the concentration of these allergens. According to Palmas et al. [12], a small concentration of these two allergens is found when relative humidity of the homes is about 45% and temperature ranges between 20˚-22˚C. This consideration is particularly important for Punjab where the warm and humid climate makes indoor dust mites and fungal spores an important source of allergens.

5. Conclusion

The present study was intended to identify the major indoor allergens (dust mites and fungal spores) that are contributing the indoor air pollution which is responsible for allergic rhinitis and asthma in the population of Punjab. Proper history taking followed by skin tests and fungal culture in specific cases are helpful in the diagnosis of these allergic manifestations and their treatment.

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Ethical approval

Permission wide letter no-248/DLS/HG was obtained from the institutional ethics committee, Punjabi university, Patiala, Punjab, India to perform the required procedure during the study.

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