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### Prevalence of aeroallergens in patients of bronchial asthma and/or allergic rhinitis in India based on skin prick test reactivity

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## Abstract

**Background:** Exposures to various aeroallergens play a crucial role in the pathogenesis of bronchial asthma (BA) and allergic rhinitis (AR). On the basis of climate change, the prevalence of aeroallergens may vary in different regions. **AIMS:** The aim of the study was to determine the prevalence of the sensitivity to aeroallergens among patients with BA and/or AR based on skin prick test (SPT) reactivity in India. **Settings And Design:** This study was conducted at National Centre of Respiratory Allergy, Asthma and Immunology and Department of Respiratory Allergy and Applied Immunology, (Department of Respiratory Medicine), Vallabhbhai Patel Chest Institute, University of Delhi, Delhi-110007 (India). **Subjects And Methods:** A total of 4835 patients were screened from the Outpatient Department of institute during the period of August 2008 to July 2016. Out of 4835 patients, 4263 patients were performed SPT consisting of 2361 (55.38%) males and 1902 (44.62%) females, with a mean age of 30.06 years were included in the study. Diagnosis of BA and AR was made according to the GINA and ARIA guidelines, respectively. SPT was done with 58 different types of aeroallergens, which included grass pollens, weed pollens, tree pollens, dust, fungi, insects, kapok cotton, wool, and silk antigens. **Statistical Analysis Used:** Data analysis was done using Excel 2007. **Results:** Significant skin positive reaction (2 + and above) against aeroallergens were found in 1993 (46.77%) participants including 422 (9.9%) BA patients, 570 (13.37%) AR patients, and 1001 (23.48%) of both BA/AR. The younger adults aged 20–29 years were the foremost commonly affected group with 626 (14.68%) significant skin-positive patients. Among individual allergens, most common aeroallergen was mosquito (30.89%) and least common was Ehretia (0.37%). **Conclusions:** In different states of India, the mosquito was found the most common sensitizing allergen in BA and/or AR patients. Sensitization was the most common in the younger age group (20–29 years) patients.

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## Full Text

## Introduction

Aeroallergens play an important role in the pathogenesis of respiratory allergic diseases. Pollens, molds, house dust mites (HDMs), and pets are the most common allergens.[1],[2] The type of aeroallergens, however, differs widely depending on localities and even varies both within and between countries.[3] In the United States, the report of Centers for Disease Control-1998, Asthma is a major public unhealthiness and affects more than 17 million people.[4] The prevalence of asthma has increased in the United States and worldwide.[5],[6],[7],[8],[9],[10] Allergic rhinitis (AR) also recognized as a risk factor for bronchial asthma (BA), with 20%–30% of such patients having BA; conversely, 60%–80% of patients with BA have coexisting AR.[11],[12] In the airways, when inhaled allergens interact with IgE antibodies on cells that causes AR, subsequently causing degranulation of mast cells and release of chemical mediators.[13] Sensitization to perennial aeroallergens was associated with asthma among families of asthmatic participants in rural China and sensitization to silk was the strongest predictor of rhinitis.[14] Some other studies conducted in industrialized countries also shown that skin test reactivity to perennial aeroallergens is strongly associated with asthma.[15],[16],[17],[18],[19],[20] and skin test reactivity to pollen is more closely correlated with AR.[19],[20] In Iran, indoor allergens, especially HDMs, were the most prevalent allergen in the region with hot and high humidity climate and the sensitivity to weeds pollen, cat, and feather allergens was significantly associated with the severity of asthma or AR.[21] Identification of the most prevalent aeroallergens, to which the patients are sensitized, has an important role in the diagnosis and treatment of BA and AR. Skin allergy testing through skin prick test (SPT) is a useful method to demonstrate hypersensitivity to a specific antigen. SPT has been found to be more sensitive and specific than radioallergosorbent test.[22] Skin allergic reaction testing with the help of SPT is a useful method to demonstrate hypersensitivity to a specific antigen.

### Aim

The aim of our study was to determine the prevalence of sensitivity to aeroallergens among patients with BA, AR, and both. Bronchial hyperresponsiveness to histamine challenge test in patients based on SPT reactivity. For better diagnosis and treatment of allergic patients, the knowledge about sensitization to these aeroallergens is a great importance guide for clinicians.

## Subjects and Methods

### Subjects

A retrospective study was conducted in patients with BA and/or AR, attending Department of Respiratory Allergy and Applied Immunology at the National Center for Respiratory Allergy, Asthma, and Immunology, Vallabhbhai Patel Chest Institute (VPCI), University of Delhi, Delhi, India. The study protocol was approved by the Institutional Ethics Committee and informed consents were obtained from the patients. Allergy testing was performed during the period of August 2008 to July 2016. A total of 4835 patients were screened from the Outpatient Department of institute during the period of August 2008 to July 2016. Out of 4835 patients, 4263 patients were performed SPT consisting of 2361 (55.38%) males and 1902 (44.62%) females, with a mean age of 30.06 years were included in the study. Diagnosis of BA and AR was made according to the GINA-2011 and ARIA guidelines, respectively.[23],[24] All patients were nonsmokers. There was no associated history of tuberculosis, diabetes mellitus, hypertension, endocrine disease, or coronary artery disease. Pregnant females were excluded from the study. Hemogram, sputum, and chest radiography were done to rule out an alternative diagnosis.

### Skin prick tests

SPT was done with 58 different types of allergens, which included 5 types of grass pollens, 16 types of weed pollens, 11 types of tree pollens, 4 types of dust, 12 types of fungi, and 6 types of insects, HDM, kapok cotton, wool, and silk antigens. Buffered saline and histamine were used as negative and positive controls, respectively. SPT was performed by applying a drop of antigen on the healthy skin on the volar surfaces of the forearm and pricking it with 26.5 gauge needle. Reading was interpreted after 15–20 min. Assessment of skin reactivity was done by calculating the mean diameter as  $(D + d)/2$ ;  $D$  = largest diameter and  $d$  = orthogonal or perpendicular diameter at the largest width of  $D$  after 15–20 min. A positive result (2+ and above) to a specific allergen is indicated by a mean wheal diameter measuring 3 mm or more, greater than negative control (buffered saline).[25] A mean wheal diameter measuring 3 mm or greater than negative control (buffered

saline) but <5 mm was taken as 2+. Similarly, a mean wheal diameter measuring  $\geq 5$  mm and <7 mm was taken as 3+,  $\geq 7$ , and <9 mm as 4+ and so on, respectively.[25] Only 2+, 3+, and 4+ reactions were labeled as significantly positive skin reactions because of the high incidence of 1+ reaction in nonallergic normal people.[25] Before performing SPT, oral drugs including antihistamines, steroids, and any other drugs considered to affect SPT were stopped 1 week before the tests, but inhaled drugs were continued. Oral short-acting antihistamines were stopped 1 week before, and long-acting antihistamines were stopped 4 weeks before performing the tests.

## Results

There was a total of 4263 patients consisting of 2361 (55.38%) males and 1902 (44.62%) females; in the age group of 2–82 years (mean age of 30.06 years). The patient's details are given in [Table 1]. The maximum number of patients (1442; 33.82%) were enrolled between the age group of 20–29 years [Table 2]. The maximum number of patients (1614; 37.86%) had a duration of suffering ranging from 1 to 5 years [Table 3].{Table 1}{Table 2}{Table 3}

Patients diagnosed with BA were 838 (19.66%), AR were 1169 (27.42%), and BA and/or AR were 2256 (52.92%) [Table 4] and [Figure 1]. Patients with BA and/or AR (1001; 23.48%) found significantly high skin sensitivity against aeroallergens (2+ and above) in comparison of AR (570; 13.37%) and BA (422; 9.9%) [Table 4] and [Figure 1].{Figure 1}{Table 4}

In our study, a total of 247,254 SPTs were performed with a total of 58 allergens on 4263 patients, of which 1223 (28.69%) patients had no reaction at all from SPT, whereas 1047 (24.56%) patients had a SPT positive (positive only with 1+ allergen). Significant skin positive reactions (2+ and above) were found in 1993 (46.75%) participants [Table 5]. The younger adults aged 20–29 years were the most commonly affected group with 626 (14.68%) significant skin-positive patients [Table 2].{Table 5}

### Offending allergens

In our study, insects (39.17%) were the most common aeroallergens followed by various types of HDM (11.99%), weed pollens (11.61%), dust (10.51), fungal spores (6.17%), tree pollen (6.12%), grass pollens (4.8%), kapok cotton (2.23%), silk (1.97%), and wool (0.42%) were the offending allergens. [Table 6] and [Figure 2].{Figure 2}{Table 6}

Among individual allergens, most common aeroallergen was mosquito (30.89%) and least common was Ehretia (0.37%). Among grass pollens, Cynodon (2.63%) was the most common allergen showing significant positive SPT followed by Sorghum (2.49%), Cenchrus (2.18%), Pennisetum (2.08%), and Imperata (1.45%) [Table 7].{Table 7}

Among weed pollens, Gynandropsis (6.57%), Amaranthus spinosus (4.2%), and Ageratum (4.2%) were most common followed by Brassica (3.45%), Cassia occidentalis (3.26%), Artemisia (3.21%), Parthenium (2.98%), Suaeda (2.74%), Adhatoda (2.74%), Argemone (2.63%), Dodonaea (2.25%), Asphodelus (2.2%), Chenopodium M (2.18%), Cannabis (2.13%), Chenopodium album (1.76%), and Xanthium (1.55%) [Table 7].

Among tree pollens, Ricinus (4.41%), Prosopis (3.82%), and Holoptelea (3.61%) were most common followed by Salvadora (3.45%), Cassia Siamea (2.55%), Morus (2.42%), Melia (2.25%), Putranjiva (2.2%), Kigelia (0.77%), and Eucalyptus (0.56%) and least common was Ehretia (0.37%) [Table 7].

Among dusts, the wheat dust (7.25%) was the most common, followed by house dust (6.12%) and cotton dust (2.56%) and the least common was paper dust (1.52%). HDM was significantly positive in 511 (11.99%) participants [Table 7].

Among the fungal spores, Aspergillus fumigatus (3.66%) was the most common followed by Epicoccum (3.35%), Rhizopus (2.72%), Aspergillus tamarii (2.67%), Alternaria (2.6%), Trichoderma (1.88%), Phoma (1.8%), Helminthosporium (1.61%), Curvularia (1.47%), Cladosporium (1.17%), and Candida (1.17%) and the least common was Mucor (1.1%) [Table 7].

Among insects, mosquito (30.89%) and moth (29.93%) were the most common allergen showing significant positive skin reaction, followed by housefly (28.78%), cockroach-male (24.41%), and cockroach-female (24.25). The least common was rice weevil (16.58%). Kapok cotton was significantly positive in 95 (2.23%) patients, silk in 84 (1.97%) patients, and wool in 18 (0.42%) patients [Table 7].

Age-wise sensitivity of aeroallergens ( $\leq 10$  years, 11–19 years, and  $\geq 20$  years)

The analysis of the sensitization rates according to age groups is shown in [Table 8]. Although there was a general trend toward a decline in the frequency of sensitization with age, very high differences were seen between the age groups for most of the allergens. The distinct exceptions for which there was a striking preponderance of sensitization among children of age group  $\leq 10$  years compared with children of age group of 11–19 years and adults of age group  $\geq 20$  years (which ranged from 2.73% to 4.55% for the  $\leq 10$  years age group) declined sharply to  $1.1 \pm 18.7\%$  in the children with age groups of 11–19 years [Table 8].{Table 8}

In grass pollens, Imperata and Sorghum were highly sensitive to children of age group  $\leq 10$  years, and except Cynodon, Cenchrus, and Pennisetum were found highly sensitive to the children of age group  $\geq 20$  years in comparison of children of age group  $\leq 10$  years and 11–19 years [Table 8].

Sensitization of Alternaria was found high in the children of age group of 11–19 years in comparison of  $\leq 10$  years age group and  $\geq 20$  years. Candida and Helminthosporium were also highly sensitive to children of age group  $\leq 10$  years and age group  $\geq 20$  years. HDM found highly sensitive to adults ( $\geq 20$  years) than other two age group children. Among dusts, wheat dust was highly sensitive to children of age group  $\leq 10$  years compared with children of age group 11–19 years and adults ( $\geq 20$  years). In tree pollens, except cassia siamea, all other tree pollens were found highly sensitive to the children age group  $\leq 10$  years in comparison of children age group 11–19 and  $\geq 20$  years. In weed pollen, Ageratum, Argemone, Asphodelus, Cannabis, and Xanthium were found highly sensitive to the children of age group  $\leq 10$  years in comparison of children of age group 11–19 and  $\geq 20$  years and other weed allergens except Dodonaea, Gynandropsis, and Suaeda were found highly sensitive to the children with age group of 11–19 years [Table 8].

#### Year-wise distribution of patients and skin reactivity in patients

Most of patients (756; 17.73%) were enrolled in the year 2011 followed by 2015 (653; 15.32%), 2013 (593; 13.91%), 2014 (502; 11.78%), 2012 (489; 11.47%), 2010 (468; 10.98%), 2016 (456; 10.69%), 2009 (255; 5.98%), and 2008 (91; 2.13%). In 2011, highly SPT-positive patients (360; 8.44%) were found, followed by the years 2015 (7.98%), 2013 (7.13%), 2012 (5.02%), 2016 (6.03%), 2014 (5.82%), 2010 (3.75%), 2009 (1.83%), and 2008 (0.75%) [Table 9].{Table 9}

#### State-wise highly skin sensitive aeroallergen

Out of 4263 patients, we had only 3027 (71%) patient's data regarding their state. Research study centre is present in Delhi, so the mostly patients were enrolled from this Delhi (2166; 50.8%) followed by neighbor states (Uttar Pradesh [455; 10.68%], Haryana [256; 6%], and Bihar [52; 1.21%]). Most of the sensitivities of aeroallergens were found in Delhi (1047; 24.56%), followed by Uttar Pradesh (199; 4.67%), Haryana (105; 2.46%), and Bihar (26; 0.61%) [Table 10].{Table 10}

In Delhi (543; 12.74%), Uttar Pradesh (144; 3.4%), and Haryana (74; 1.7%), Mosquito was found mostly high skin sensitive aeroallergen in patients of BA and/or AR in comparison of other aeroallergens. In Bihar (16; 0.4%), Madhya Pradesh (6; 0.14%), Rajasthan (8; 0.19%), and Uttarakhand (4; 0.1%), housefly was found as high skin sensitive aeroallergen which shows high skin reactivity in patients of BA and/or AR in comparison of other aeroallergens [Table 10], [Figure 3] and [Figure 4].{Figure 3}{Figure 4}

## Discussion

The results of our study showed that the sensitizing aeroallergens among patients with AR and asthma were mosquitoes, dusts, weeds, trees, fungi, and grass pollens, respectively. It was observed that indoor aeroallergens mainly insects including mosquito, cockroach, and moth allergens were more prevalent than other aeroallergens.

In the present study, a maximum number of patients (1442; 33.82%) were the younger adults aged 20–29 years, and they were the most commonly affected group with 626 (14.68%) significant skin positive patients. Studies done in the year 2003 and 2012 at VPCI also showed a maximum number of patients in age groups of 20–30 years (120; 35.19%) and (261; 28.43%), respectively, and this group was the most commonly affected with significant skin-positive patients.[26],[27]

In our study, insects were most common offending aeroallergens with 39.17%, followed by various types of HDM (11.99%), weed pollens (11.61%), dust (10.51%), fungal spores (6.17%), tree pollens (6.12%), grass pollens (4.8%), kapok cotton (2.23%), silk (1.97%), and wool (0.42%). Two studies (2012 and 2003) done at our institute, in which the study of 2012 was revealed that insects were most common offending aeroallergens with 43.90%, followed by various types of weed pollens (21.79%), tree pollens (15.14%), dust (14.49%), HDM (12.42%), fungal spores (11.98%), grass pollens (7.73%), kapok

cotton (2.18%), silk (1.30%), and wool (0.76%). Another study (2003) also revealed that most common aeroallergens showing markedly positive tests were insects with 17.29%, followed by various types of dust (4.39%), grass pollen (2.28%), weed pollens (2.18%), tree pollens (1.22%), fungal spores (1.22%), and kapok fiber (1.75%).[26],[27] Wool, silk, and dust mite were not done in the study 2003. Gynandropsis, Artemisia Ricinus, and Epicoccum were not tested in previous studies. The comparison between our three studies is depicted in [Table 11] and [Table 12] and [Figure 5]. Ghaffari et al. in 2010 showed that most common SPT reaction was with HDM, i.e., Dermatophagoides pteronyssinus (25.3%) and Dermatophagoides farina (24.8%), followed by cockroach (15.7%) and feather (7.5%).[28] Similar results were obtained in Jamaican study done by Madden KJ, which showed that most common significant SPT was due to Dermatophagoides pteronyssinus (33%) and Dermatophagoides farina (32%) followed by cockroach (23%).[29] A study done by Almorgen et al. revealed that most frequently reacting indoor allergen was HDM (77.8%) followed by the cat (33.6%) and cockroach (19.2%) allergens.[29],[30] Patient's details are given in [Table 12].{Figure 5}{Table 11}{Table 12}

In this study among insects, mosquito (30.89%) was the most common aeroallergen showing significant positive skin reaction followed by moth (29.93%), housefly (28.78%), cockroach male (24.25%), and cockroach female (24.25%). The least common was rice weevil (12.71%). The previous study in 2003 done at VPCI revealed that housefly was the most important insect allergen with 25.21% of the patients showing a markedly positive skin reaction, followed by mosquito (21.11%), moth (19.94%), female cockroach (17.59%), male cockroach (9.97%), and rice weevil (9.38%) in that order.[26] Another previous study of 2012 done at VPCI revealed that moth (33%) was the most common allergen showing significant positive skin reaction followed by mosquito (31.92%), housefly (26.36%), cockroach male (19.06), and cockroach female (18.63). The least common was rice weevil (12.75%).[27] Patients' details are given in [Table 12] and [Figure 5].

In the present study, among weed pollens, Gynandropsis (6.57%) followed by Amaranthus spinosus (4.2%) and Ageratum (4.2%) were most common and least common was Xanthium (1.55%). In the previous study (2012), Ageratum (5.45%) followed by Brassica (4.90%) and Amaranthus spinosus (4.58%) were most common and least common was Chenopodium album (1.53%)[27] and in another study (2003) showed that Brassica (5.27%), Amaranthus spinosus (4.98%), Argemone (4.98%), and Amaranthus H.(3.51%) were the common weed allergens.[26] Patients' details are given in [Table 12] and [Figure 5].[26]

In our study, among tree pollens, Ricinus (4.41%), Prosopis (3.82%), and Holoptelia (3.61%) were most common and least common were Ehretia (0.37%). In previous study (2003) done at VPCI, Salvadora (2.34%), Ailunthus (1.75%), Prosopis (1.75%), and Cassia siamea (1.46%) were the more commonly implicated tree pollens, and Morus did not show any markedly positive result at all.[14] In our another study (2012), in tree pollens, Holoptelia (5.01%) followed by Salvadora (4.36%) was most common and least common was Ehretia (0.54%). Patient's details are given in [Table 12] and [Figure 5].

In our study, when dust allergens were tested through SPT, among dust, the wheat dust (7.25%) was the most common, followed by house dust (6.12%) and cotton dust (2.56%), but the least common was paper dust (1.52%). HDM was significantly positive in 511 (11.99%) subjects. In our previous study (2012), wheat dust (8.28%) was the most common, followed by house dust (7.08%) and cotton dust (1.63%), but the least common was paper dust (1.53%). Earlier study (2003) at VPCI showed that cotton dust (6.47%) was the most commonly implicated dust followed by wheat dust (5.86%), paper dust (3.81%), and house dust (1.46%).[26],[27] Patients' details are given in [Table 12] and [Figure 5].

Among the fungal spores, Aspergillus fumigatus (3.66%) was the most common followed by Epicoccum (3.35%) and Rhizopus (2.72%) but the least common was Mucor (1.1%). However, in our previous study (2012), Aspergillus fumigates (4.25%) followed by rhizopus (3.81%) were the most common and least common was candida (1.09%) among the fungal spores. In 2003 study, most common fungal spores with significant skin reaction were Mucor (2.05), Aspergillus Fumigatus (2.05%), Rhizopus (1.75%), and Fusarium (1.75%).[26],[27] Patient's details are given in [Table 12] and [Figure 5].

Among grass pollens, Cynodon (2.63%) was most common allergen showing significant positive SPT followed by Sorghum (2.49%) and lest common was Imperata (1.45%). In our previous study (2012), Cynodon (3.05%) followed by Cenchrus (1.96%) were most common and least common was Pennisetum (1.74%). In another our previous study (2003), Cynodon (4.10%) and lest common was Imperata (2.34%).[26],[27] In our study, Kapok Cotton was significantly skin positive in 95 (2.23%) patients, silk in 84 (1.97%) patients, and wool in 18 (0.42%) patients. HDM was significantly positive in 511 (11.99%) subjects. In our previous study (2012), Kapok Cotton was significantly positive in 20 (2.18%) patients, wool in 7 (0.76%), and silk in 12 (1.31%). HDM was significantly positive in 114 (12.42%) subjects.[27] Earlier study (2003) reported that Kapok fiber was marked positive in 1.76% patients, but they did not test for wool, silk, and HDM.[26] Singhal P's study from different parts of the world has implicated HDMS as most common offending aeroallergens among Malaysian asthmatic patients [31] and patients with AR in Thailand [32], Singapore [33], and Mexico City.[34] Patients' Details are given in [Table 12] and [Figure 5].

## Conclusion

In our study, we showed the importance of pollens, dusts, fungi, and insects as sensitizing aeroallergens in patients with allergy in north region of India. The variation in the prevalence of aeroallergen reactivities in a different region is due to different geo-climatic condition and adaptation of specific microbiological flora and fauna in specific climate. Avoidance for mosquito, houseflies, and HDM may result in improvement of symptoms in allergic patients. This study will help for selecting the panel of most common aeroallergens for SPT and will also help in finding the best specious of allergens for immunotherapy in this area. We also try to observe state-wise sensitivity of aeroallergens, in which we found insects (mosquito, housefly and cockroach) are high skin sensitive aeroallergens in most states (Delhi, Bihar, Haryana, Madhya Pradesh, and Uttar Pradesh).

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Conflicts of interest

There are no conflicts of interest.

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