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Pattern of skin sensitivity to various aeroallergens in patients of bronchial asthma and/or allergic rhinitis in India

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Abstract

Nine hundred and eighteen patients with bronchial asthma and/or allergic rhinitis including 548 (59.69%) males and 370 (40.31%) females with a mean age of 30.10 years were studied for skin sensitivity to various aeroallergens by skin prick test. The maximum numbers of patients (261; 28.43%) were between age group of 20 to 29 years. Patients diagnosed with bronchial asthma were 191 (20.81%), allergic rhinitis were 305 (33.22%), and both bronchial asthma and allergic rhinitis were 422 (45.97%). Significant skin positive reactions (2+ and above) were found in 657 (71.57%) subjects, which included 130 (14.16%) of bronchial asthma patients, 208 (22.66%) of allergic rhinitis patients, and 319 (34.75%) of both. The younger adults aged 20-29 years were the most commonly affected group with 197 (21.46%) significant skin positive patients. Insects (43.90%) followed by various types of weed pollens (21.79%), tree pollens (15.14%), dust (14.49%), house dust mite (12.42%), fungal spores (11.98%), grass pollens (7.73%), kapok cotton (2.18%), silk (1.31%), and wool (0.76%) were the offending allergens. Among individual allergens, most common aeroallergen was moth (33%), and least common was *ehretia* (0.54%). Among grass pollens, *Cynodon* (3.05%) was most common, and least common grass pollen aeroallergen was *Pennisetum* (1.74%). Among weed pollens, *Ageratum* (5.45%) was most common, and least common was *Chenopodium album* (1.53%). Among tree pollens, *Holoptelia* (5.01%), was most common, and least common was *Ehretia* (0.54%). Among dust, the wheat dust (8.28%) was the most common, followed by house dust (7.08%), and least common was paper dust (1.53%). Among the fungal spores, *Aspergillus fumigatus* (4.25%) were the most common, and least common was *Candida* (1.09%). Among insects, moth (33%) followed by mosquito (31.92%) were the most common, and least common was rice weevil (12.75%). When compared with the pattern of our study, there was significantly increased in sensitization to various allergens.

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Full Text

Introduction

The clinical association of upper and lower airway inflammation is well-recognized. Both bronchial asthma (BA) and allergic rhinitis (AR) frequently co-exist and are now thought to be a continuum of inflammation involving one common airway. [1] Allergic rhinitis is a recognized risk factor for bronchial asthma, with 20%-30% of such patients having bronchial asthma; conversely 60%-80% of patients with bronchial asthma have co-existing AR. [2],[3] Asthma is a major cause of chronic morbidity and mortality throughout the world that is characterized by paroxysmal spasmodic narrowing of the bronchial airway due to inflammation of the bronchial tree and contraction of the bronchial smooth muscle. [4] Allergens can initiate an acute attack of asthma in sensitized subjects. Allergic rhinitis is an inflammatory condition of the nasal mucosa characterized by the symptoms of pruritus, sneeze, discharge, and stuffiness induced by an immunoglobulin-E (IgE) - mediated response. [5] Allergic rhinitis occurs when inhaled allergens interact with IgE antibodies on cells in the airway, subsequently causing degranulation of mast cells and release of chemical mediators. [6] While allergic rhinitis is not a life-threatening condition (unless accompanied by severe asthma or anaphylaxis), complications can occur, and the condition can significantly impair quality of life. [7] BA and AR are the most common allergic condition. Allergic condition have increased since past decades and are posing a heavy burden on health care system. [5] Exposures to various aeroallergens play an important role in pathogenesis of bronchial asthma and allergic rhinitis. The types of aeroallergens, however, differ widely depending on localities and even varies both within and between countries. [8] 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 via skin prick test (SPT) is a useful method to demonstrate hypersensitivity to a specific antigen. Skin prick testing has been found to be more sensitive and specific than radio-allergosorbent test (RAST). [9]

The present research was carried out to investigate the pattern of skin prick test reactivity to various aeroallergens among patients of respiratory allergy, i.e., BA and/or AR in India, in order to facilitate effective strategies for management of these allergic conditions.

Materials and Methods

Subjects

A retrospective study was conducted in patients with bronchial asthma and/or allergic rhinitis, attending department of Respiratory Allergy and Applied Immunology at the National Center of Respiratory Allergy, Asthma and Immunology, Vallabhbhai Patel Chest Institute (VPCI), University of Delhi, Delhi, India. Allergy testing was performed during the period of august 2008 to august 2011. A total of 918 patients consisting of 548 (59.69%) males and 370 (40.31%) females, in the age group of 6-80 years (mean age of 30.10 years), were included in the study. Diagnosis of bronchial asthma and allergic rhinitis was made according to the GINA [10] and ARIA [11] guidelines, respectively.

All patients were non-smokers. 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

Skin prick test 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 dusts, 12 types of fungi, 6 types of insects, house dust mite, kapok cotton, wool, and silk antigens. Buffered saline and histamine were used as negative and positive controls, respectively. Skin prick test was performed by applying a drop of antigen on healthy skin on the volar surfaces of the forearm, and pricking it with 26.5 gauge needle. Reading was interpreted after 15 to 20 minutes. 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 to 20 minutes. 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). [12] A mean wheal diameter measuring 3 mm or more greater than negative control (buffered saline) but less than 5 mm was taken as 2+. Similarly, a mean wheal diameter measuring ≥ 5 mm and < 7 mm was taken as 3+, ≥ 7 mm and < 9 mm as 4+ and so on, respectively. [12] Only 2+, 3+, and 4+ reactions were labeled as significantly positive skin reactions because of the high incidence of 1+ reaction in non-allergic normal people. [12]

Before performing SPT, oral drugs including anti-histamines, steroids, and any other drugs considered to affect SPT were stopped 1 week prior to the tests, but inhaled drugs were continued. Oral short acting anti-histamines were stopped 1 week

before, and long acting anti-histamines were stopped 4 weeks before performing the tests.

Results

There were a total of 918 patients consisting of 548 (59.69%) males and 370 (40.31%) females, in the age group of 6-80 years (mean age of 30.10 years). The patient's age distribution is given in [Table 1]. The maximum numbers of patients (261; 28.43%) were between age group of 20 to 29 years. The maximum number of patients (57; 62.53%) had duration of suffering ranging from 1 to 10 years [Table 2].{Table 1}{Table 2}

Patients diagnosed with bronchial asthma were 191 (20.81%), allergic rhinitis were 305 (33.22%), and both bronchial asthma and allergic rhinitis were 422 (45.97%) [Figure 1].{Figure 1}

In our study, a total of 53244 skin prick tests were performed with a total of 58 allergens on 918 patients, out of which only 6 (0.65%) patients had no reaction at all from SPT, whereas 255 (27.78%) patients had a positive SPT up to the 1+ grade (mean wheal diameter measuring less than 3 mm). Significant skin positive reactions (2+ and above) were found in 657 (71.57%) subjects. The younger adults aged 20-29 years were the most commonly affected group with 197 (21.46%) significant skin positive patients [Table 3].{Table 3}

Insects (43.90%) followed by various types of weed pollens (21.79%), tree pollens (15.14%), dust (14.49%), house dust mite (12.42%), fungal spores (11.98%), grass pollens (7.73%), kapok cotton (2.18%), silk (1.31%), and wool (0.76%) were the offending allergens [Figure 2].{Figure 2}

Among individual allergens, most common aeroallergen was moth (33%) and least common was ehretia (0.54%).

Among grass pollens, Cynodon (3.05%) was most common allergen showing significant positive SPT followed by Cenchrus (1.96%), Sorghum (1.85%), Pennisetum (1.74%), and Imperata (1.74%).

Among weed pollens, Ageratum (5.45%) was most common followed by Brassica (4.90%), Amaranthus spinosus (4.58%), Gynandropsis (4.36%), Cassia occidentalis (3.38%), Asphodelous (3.38%), Artemisia (3.16%), Adhatoda (2.83%), Argemone (2.51%), Parthenium (2.29%), Dodonaea (2.29%), Cannabis (2.18%), Suaeda (2.07%), Chenopodium M (2.07%), Xanthium (1.85%), and Chenopodium album (1.53%).

Among tree pollens, Holoptelia (5.01%) was most common followed by Salvadora (4.36%), Prosopis (3.81%), Ricinus (3.70%), Cassia siamea (3.70%), Morus (3.27%), Melia (2.94), Putranjiva (1.85%), Kigelia (0.87%), Eucalyptus (0.76%), and least common was Ehretia (0.54%).

Among dust, the 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%).

House dust mite was significantly positive in 114 (12.42%) of subjects.

Among the fungal spores, Aspergillus fumigatus (4.25%) was the most common followed by Rhizopus (3.81%), Aspergillus tamari (3.38%), Epicoccum (2.83%), Phoma (2.51%), Helminthosporium (2.51%), Alternaria (2.40%), Trichoderma (2.29%), Curvularia (1.85%), Cladosporium (1.20%), and Mucor (1.20%), but the least common was Candida (1.09%).

Among insects, 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%).

Kapok Cotton was significantly positive in 20 (2.18%) patient, wool in 7 (0.76%), and silk in 12 (1.31%) [Table 4].{Table 4}

Discussion

Aeroallergens are the prominent causes of allergic symptoms in patients with BA or AR. Different types of environmental aeroallergens are known to play a role in triggering or exacerbating BA or AR. Identification of the most prevalent

aeroallergens in each area has a very important role in diagnosis and treatment of BA and/or AR. The SPT is the recommended initial investigation to find out the offending aeroallergens. [13] In our study, this was validated as significant skin positive reactions (2+ and above) were found in 657 (71.57%) subjects, and only 6 (0.65%) patients had no reaction at all from SPT, whereas 255 (27.78%) patients had a positive SPT up to the 1+ grade. In our study, all the patients showing significant skin positive reaction had poly-sensitization to more than two aeroallergens. Similar study done in 1997-2000 at Vallabhbhai Patel Chest Institute, University of Delhi, Delhi, India by us had shown that 29.03% of the patients who suffer BA and/or AR do not have an allergic component, 19.35% had grades of 1 + to some of the antigens tested, and 51.62% showed significant skin positive reaction [14] using intra-dermal skin test method compare is summarized in [Figure 3]. A study done in Iran by Ghaffari J et al. showed that SPT was positive for 156 (41.5%) patients with diagnosis of BA and/or AR. [15] A retrospective cross-sectional study done by Almogren A showed that SPT was positive for 75% of patient with respiratory allergy, i.e., BA and/or AR. [16] A cross-sectional retrospective study done recently by Farhoudi A et al. on patients with similar diagnosis showed significant positive SPT reaction in 154 (68%) subjects. [17]{Figure 3}

In our study, maximum numbers of patients (261; 28.43%) were the younger adults aged 20-29 years, and they were the most commonly affected group with 197 (21.46%) significant skin positive patients. Study done earlier at VPCI also showed maximum number of patients (120; 35.19%) in age group of 20-30 years, but further assessment was not carried out for most sensitized age group. [14]

In our study, 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%), house dust mite (12.42%), fungal spores (11.98%), grass pollens (7.73%), kapok cotton (2.18%), silk (1.30%), and wool (0.76%). A study done at our institute by us also revealed that most common aeroallergen 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%). [14] The comparison between our two studies is depicted in [Figure 3]. Study by Ghaffari J et al. showed that most common SPT reaction was with house dust mites, i.e., *Dermatophagoides pteronyssinus* (25.3%) and *Dermatophagoides farina* (24.8%), followed by cockroach (15.7%), and feather (7.5%). [15] Similar results were obtain in Jamaican study done by Madden J k, et al., which showed that most common significant SPT were due to *Dermatophagoides pteronyssinus* (33%) and *Dermatophagoides farina* (32%), followed by cockroach (23%). [18] A study by Almorgen A revealed that most frequently reacting indoor allergen was house dust mite (77.8%) followed by the cat (33.6%) and cockroach (19.2%) allergens. [16]

In this study among insects, 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%). Previous study 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. [14]

Among weed pollens, *Ageratum* (5.45%) followed by *Brassica* (4.90%) and *Amaranthus spinosus* (4.58%) were most common, and least common was *Chenopodium album* (1.53%). Previous study done at VPCI showed that *Brassica* (5.27%), *Amaranthus spinosus* (4.98%), *Argemone* (4.98%), and *Amaranthus H.* (3.51%) were the common weed allergens. [14]

In our study, when tree pollens were tested via SPT, *Holoptelia* (5.01%) followed by *Salvadora* (4.36%) were most common, and least common was *Ehretia* (0.54%). In previous study done at VPCI, *Salvadora* (2.34%), *Ailunthus* (1.75%), *Prosopis* (1.75%), *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 study among dust, the 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 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%). [14]

Aspergillus fumigates (4.25%) followed by *rhizopus* (3.81%) were the most common, and least common was *candida* (1.09%) among the fungal spores. Singhal and Rajkumar showed that most common fungal spores with significant skin reaction were *Mucor* (2.05), *Aspergillus Fumigatus* (2.05%), *Rhizopus* (1.75%), and *Fusarium* (1.75%). [14]

Among grass pollens, *Cynodon* (3.05%) followed by *Cenchrus* (1.96%) were most common, and least common was *Pennisetum* (1.74%) as revealed by our study. Previous study showed that *Cynodon* (4.10%), *Pennisetum* (2.63%), and *Imperata* (2.34%) were the most common allergens [Table 5]. [14]{Table 5}

Kapok Cotton was significantly positive in 20 (2.18%) patient, wool in 7 (0.76%), and silk in 12 (1.31%). House dust mite was significantly positive in 114 (12.42%) of subjects. Earlier study reported that Kapok fiber was marked positive in 1.76%

patient, but they didn't test for wool, silk, and house dust mite. [14] Study from different parts of world has implicated house dust mites as most common offending aeroallergens among Malaysian asthmatic patients [19] and patients with AR in Thailand, [20] Singapore, [21] and Mexico City. [22]

High prevalence of skin reactivity to insects, weed pollens, tree pollens, dust, house dust mite, and fungal spores demonstrates the increase in significant skin reactivity than previous study. This is in line with increasing prevalence of respiratory allergy, i.e., BA and/or AR. The variation in the prevalence of aeroallergen reactivities in different region is due to different geo-climatic condition and adaptation of specific microbiological flora and fauna in specific climate. The variation of skin reactivity may also be attributed to change in specific pattern of vegetation over a period of time as a result of changes in geo-climatic condition. The increasing trend in skin reactivity as compared to our previous study may also be due to addition of prevalent aeroallergen like house dust mite in our study.

One of the management protocols can be avoidance of common aeroallergens prevalent in that part of world although it is not so easy. The identification of most prevalent and also the full spectrum of aeroallergens responsible for respiratory allergies (BA and/or AR) has a very important role in management of these conditions. Our study will help in selecting the most specific and most cost-effective panel of aeroallergen antigens for SPT as the appropriate diagnostic test, and hence will help in finding the best formulation of allergen specific immunotherapy as an effective treatment.

Conclusion

The study concluded that 657 (71.57%) patients of respiratory allergy, i.e., BA and/or AR in the study sample, suffered from poly-sensitization from different aeroallergens. There was a marked increase in sensitization as compared to our previous study. [14] Sensitization was most common in the younger age group of 20 to 29 years with 197 (21.46%) patients. In our study, insects (43.90) were most common offending aeroallergens, followed by various types of weed pollens (21.79%), tree pollens (15.14%), dust (14.49%), house dust mite (12.42%), fungal spores (11.98%), grass pollens (7.73%), kapok cotton (2.18%), silk (1.30%) and wool (0.76%).

The information from our study may be useful to clinicians managing patients suffering from respiratory allergies. Allergen-specific immunotherapy is a viable option for these patients. It can be used in combination with conventional therapy to maximize the outcome.

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Table 1: Number of patients in different age groups and positive reactions

Age group (years)	No. of patients	% of total	Positive patients (2+ and above)	% positive of total
≤10	21	2.29	13	1.42
10-19	194	21.13	156	16.99
20-29	261	28.43	197	21.46
30-39	226	24.62	153	16.67
40-49	131	14.27	100	10.89
50-59	64	6.97	30	3.27
60-69	18	1.96	7	0.76
70-80	3	0.33	1	0.12

Table 2: Number of patients and duration of suffering

Duration (years)	No. of persons	%
≤1	71	7.73
1-5	380	41.39
6-10	194	21.13
11-15	99	10.78
16-20	72	7.84
21-25	40	4.36
26-30	28	3.05
31-35	11	1.20
≥35	23	2.51

Figure 1: Number of patients suffering from BA and/or AR

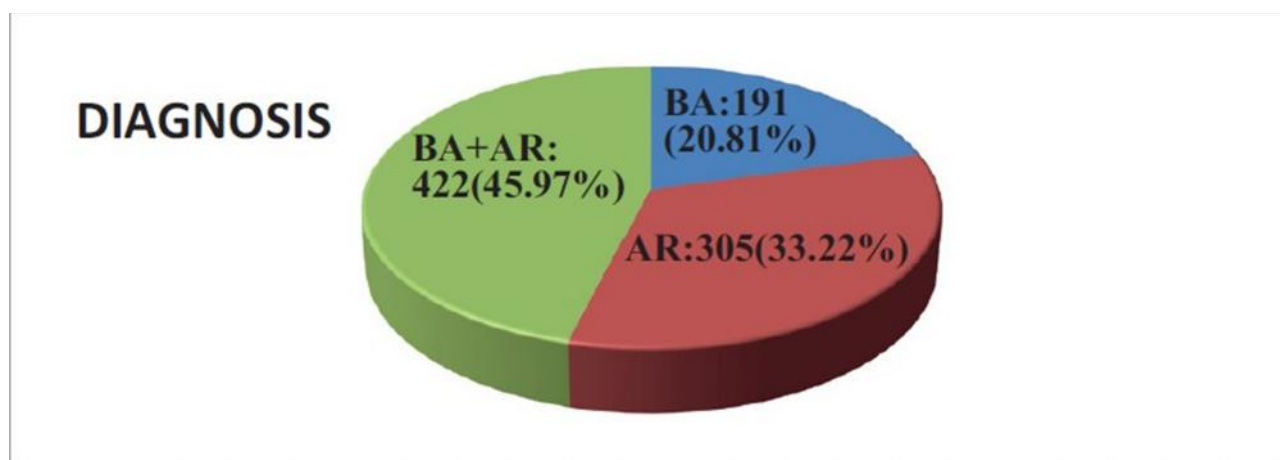


Table 3: Results of the antigens tested

Results	No. of patients	%
All negative	6	0.65
1+	255	27.78
2+ and above	657	71.57
Total	918	100

Figure 2: Offending allergens

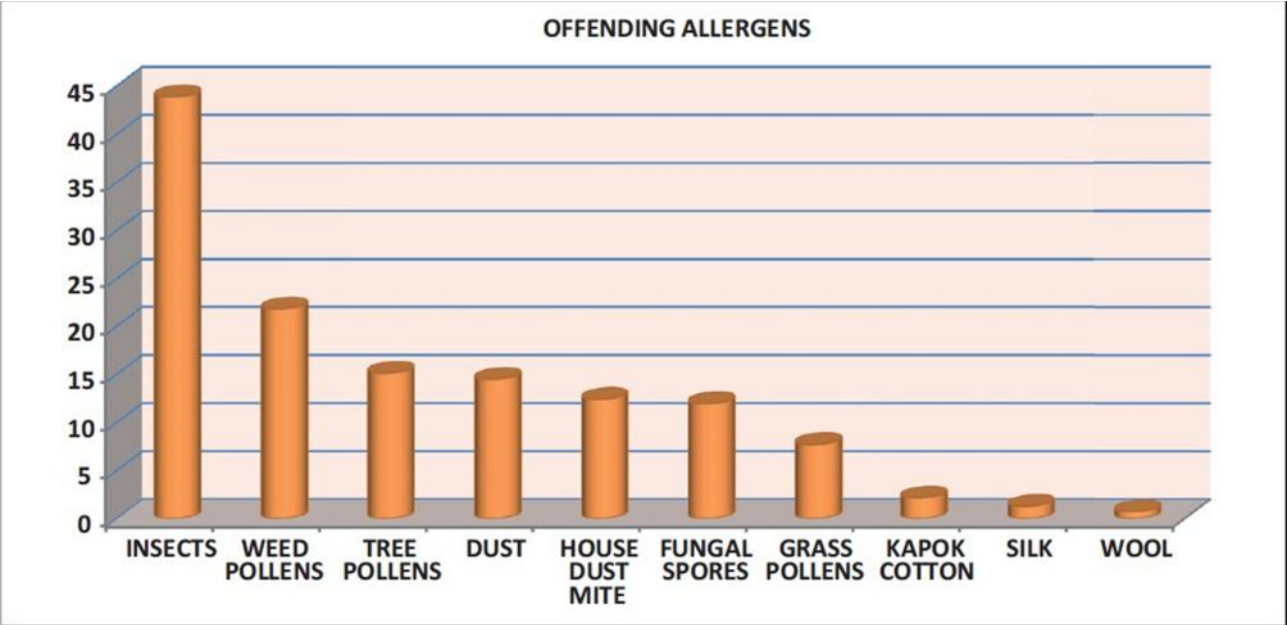


Table 4: Detailed results of all antigens tested

Allergens	2+ and above (%)	1+ (%)	2+ (%)	3+ (%)	4+ (%)
Grass pollens	71 (7.73)	201 (21.90)	63 (6.86)	7 (0.76)	1 (0.11)
<i>Cenchrus</i>	18 (1.96)	85 (9.26)	16 (1.74)	2 (0.22)	0 (0)
<i>Cynodon</i>	28 (3.05)	88 (9.59)	27 (2.94)	1 (0.11)	0 (0)
<i>Imperata</i>	16 (1.74)	68 (7.41)	15 (1.63)	1 (0.11)	0 (0)
<i>Pennisetum</i>	16 (1.74)	74 (8.06)	13 (1.42)	2 (0.22)	1 (0.11)
<i>Sorghum</i>	17 (1.85)	56 (6.10)	16 (1.74)	1 (0.11)	0 (0)
Weed pollens	200 (21.79)	434 (47.28)	174 (18.95)	17 (1.85)	9 (0.98)
<i>Adhatoda</i>	26 (2.83)	94 (10.24)	25 (2.72)	1 (0.11)	0 (0)
<i>Ageratum</i>	50 (5.45)	173 (18.85)	47 (5.12)	2 (0.22)	1 (0.11)
<i>Amaranthus spinosus</i>	42 (4.58)	156 (16.99)	40 (4.36)	1 (0.11)	1 (0.11)
<i>Argemone</i>	23 (2.51)	101 (11.00)	22 (2.40)	0 (0)	1 (0.11)
<i>Artemisia</i>	29 (3.16)	113 (12.31)	27 (2.94)	2 (0.22)	0 (0)
<i>Asphodelous</i>	31 (3.38)	96 (10.46)	30 (3.27)	1 (0.11)	0 (0)
<i>Brassica</i>	45 (4.90)	113 (12.31)	43 (4.68)	1 (0.11)	1 (0.11)
<i>Cannabis</i>	20 (2.18)	71 (7.73)	14 (1.53)	3 (0.33)	3 (0.33)
<i>Cassia occidentalis</i>	31 (3.38)	106 (11.55)	30 (3.27)	1 (0.11)	0 (0.11)
<i>Chenopodium album</i>	14 (1.53)	72 (7.84)	14 (1.53)	0 (0)	0 (0)
<i>Chenopodium M</i>	19 (2.07)	91 (9.91)	19 (2.07)	0 (0)	0 (0)
<i>Dodonaea</i>	21 (2.29)	88 (9.59)	19 (2.07)	1 (0.11)	1 (0.11)
<i>Gynandropsis</i>	40 (4.36)	208 (22.66)	38 (4.14)	1 (0.11)	1 (0.11)
<i>Parthenium</i>	21 (2.29)	85 (9.26)	20 (2.18)	1 (0.11)	0 (0)
<i>Suaeda</i>	19 (2.07)	93 (10.13)	19 (2.07)	0 (0)	0 (0)
<i>Xanthium</i>	17 (1.85)	66 (7.19)	16 (1.74)	1 (0.11)	0 (0)
Tree pollens	139 (15.14)	274 (29.85)	118 (12.85)	14 (1.53)	7 (0.76)
<i>Cassia siamea</i>	34 (3.70)	101 (11.00)	33 (3.59)	1 (0.11)	0 (0)
<i>Ehretia</i>	5 (0.54)	24 (2.61)	5 (0.54)	0 (0)	0 (0)
<i>Eucalyptus</i>	7 (0.76)	43 (4.68)	7 (0.76)	0 (0)	0 (0)
<i>Kigelia</i>	8 (0.87)	31 (3.38)	8 (0.87)	0 (0)	0 (0)
<i>Melia</i>	27 (2.94)	68 (7.41)	27 (2.94)	0 (0)	0 (0)
<i>Morus</i>	30 (3.27)	59 (6.43)	24 (2.61)	4 (0.44)	2 (0.22)
<i>Prosopis</i>	35 (3.81)	93 (29.25)	32 (3.49)	3 (0.33)	0 (0)
<i>Putranjiva</i>	17 (1.85)	69 (7.52)	16 (1.74)	1 (0.11)	0 (0)
<i>Ricinus</i>	34 (3.70)	101 (11.00)	34 (3.70)	0 (0)	0 (0)
<i>Salvadora</i>	40 (4.36)	124 (13.51)	38 (4.14)	1 (0.11)	1 (0.11)
<i>Holoptelia</i>	46 (5.01)	103 (11.22)	38 (4.14)	4 (0.44)	4 (0.44)
Dust	133 (14.49)	301 (32.79)	120 (13.07)	10 (1.09)	3 (0.33)
House dust	65 (7.08)	229 (24.95)	65 (7.08)	0 (0)	0 (0)
Wheat dust	76 (8.28)	129 (14.05)	64 (6.97)	10 (1.09)	2 (0.22)
Paper dust	14 (1.53)	83 (9.04)	13 (1.42)	0 (0)	1 (0.11)
Cotton dust	15 (1.63)	99 (10.78)	15 (1.63)	0 (0)	0 (0)
House dust mite	114 (12.42)	130 (14.16)	85 (9.26)	23 (2.51)	6 (0.65)
Fungi	110 (11.98)	201 (21.90)	85 (9.26)	20 (2.18)	5 (0.54)
<i>Alternaria</i>	22 (2.40)	64 (6.98)	19 (2.07)	1 (0.11)	2 (0.22)
<i>Aspergillus Fumigatus</i>	39 (4.25)	66 (7.19)	36 (3.92)	3 (0.33)	0 (0)
<i>Aspergillus Tamari</i>	31 (3.38)	56 (6.10)	30 (3.27)	1 (0.11)	0 (0)
<i>Candida</i>	10 (1.09)	28 (3.05)	9 (0.99)	1 (0.11)	0 (0)
<i>Cladosporium</i>	11 (1.20)	38 (4.14)	9 (0.99)	2 (0.22)	0 (0)
<i>Curvularia</i>	17 (1.85)	39 (4.25)	16 (1.74)	0 (0)	1 (0.11)
<i>Helminthosporium</i>	23 (2.51)	36 (3.92)	21 (2.29)	2 (0.22)	0 (0)
<i>Mucor</i>	11 (1.20)	31 (3.38)	10 (1.09)	1 (0.11)	0 (0)
<i>Phoma</i>	23 (2.51)	51 (5.56)	20 (2.18)	3 (0.33)	0 (0)
<i>Trichoderma</i>	21 (2.29)	39 (4.25)	14 (1.53)	5 (0.55)	2 (0.22)
<i>Rhizopus</i>	35 (3.81)	57 (6.21)	33 (3.59)	2 (0.22)	0 (0)
<i>Epicoocum</i>	26 (2.83)	75 (8.17)	23 (2.51)	3 (0.33)	0 (0)
Insects	403 (43.90)	482 (52.51)	171 (18.63)	168 (18.30)	64 (6.97)
Cockroach (M)	175 (19.06)	286 (31.15)	148 (16.12)	21 (2.29)	6 (0.65)
Cockroach (F)	171 (18.63)	290 (31.59)	145 (15.80)	19 (2.07)	7 (0.76)
Housefly	242 (26.36)	289 (31.48)	185 (20.15)	43 (4.68)	14 (1.53)
Rice weevil	117 (12.75)	228 (24.84)	105 (11.44)	7 (0.77)	5 (0.54)
Mosquito	293 (31.92)	271 (29.52)	223 (24.29)	45 (4.90)	25 (2.72)
Moth	303 (33.00)	246 (26.80)	263 (28.65)	33 (3.59)	7 (0.76)
Others					
Kapok cotton	20 (2.18)	43 (4.68)	18 (1.96)	0 (0)	2 (0.22)
Wool	7 (0.76)	24 (2.61)	6 (0.65)	1 (0.11)	0 (0)
Silk	12 (1.31)	79 (8.61)	11 (1.20)	1 (0.11)	0 (0)

Figure 3: Comparison of significant positive aeroallergens between our two studies. *These aeroallergens were not tested in 1997-2000 stud

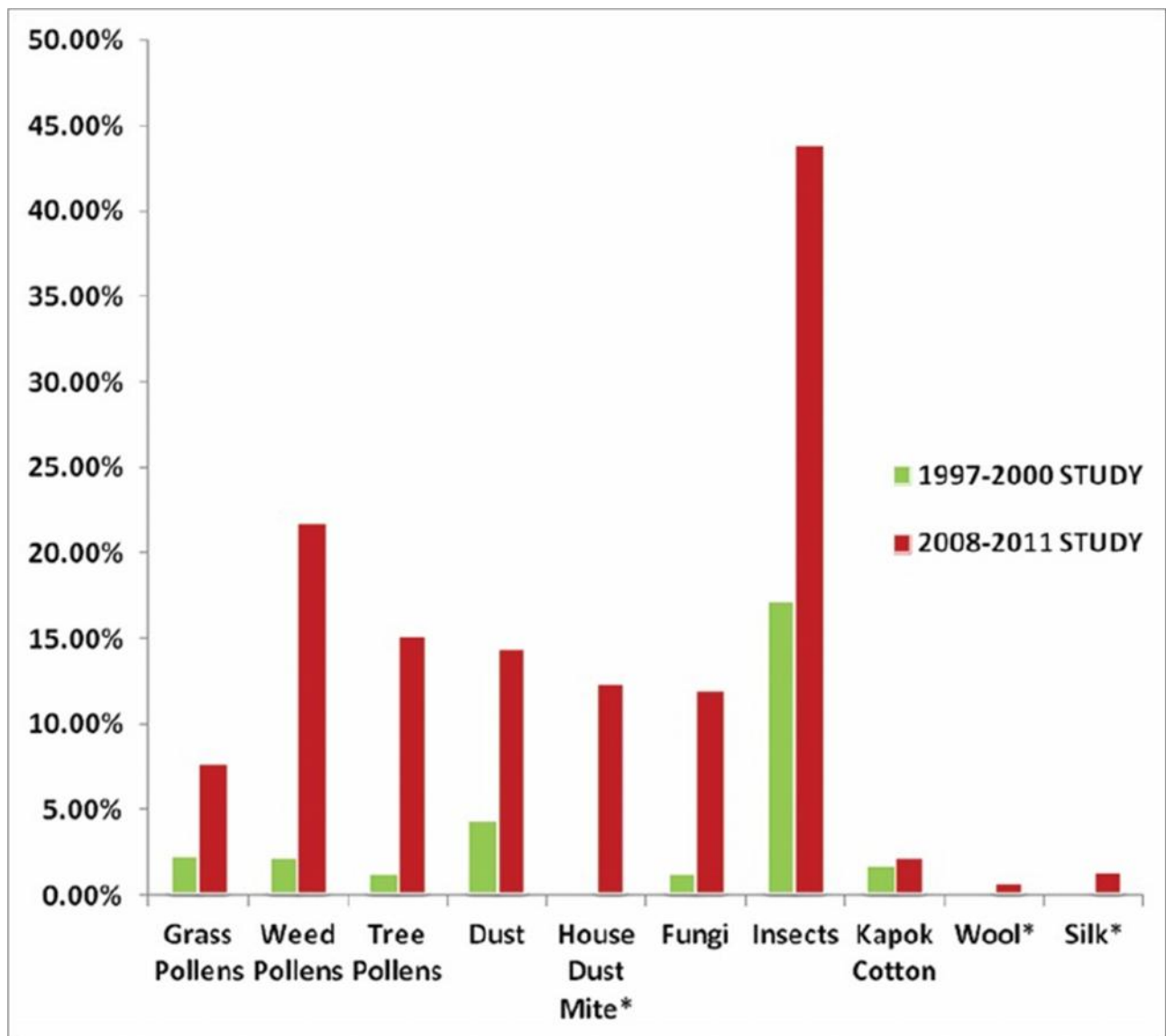


Table 5: Comparison of various offending aeroallergens between our two studies

Aeroallergens	2008-2011 study (%)	1997-2000 study (%)
Grass pollen commonest	<i>Cynodon</i> (3.05) <i>Cenchrus</i> (1.96) <i>Sorghum</i> (1.85)	<i>Cynodon</i> (4.10) <i>Pennisetum</i> (2.63) <i>Imperata</i> (2.34)
Weed pollen commonest	<i>Ageratum</i> (5.45) <i>Brassica</i> (4.90) <i>Amaranthus spinosus</i> (4.58)	<i>Brassica</i> (5.27) <i>Amaranthus spinosus</i> (4.98) <i>Argemone</i> (4.98)
Tree pollen commonest	<i>Holoptelia</i> (5.01) <i>Salvadora</i> (4.36) <i>Prosopis</i> (3.81)	<i>Salvadora</i> (2.34) <i>Ailunthus</i> (1.75) <i>Prosopis</i> (1.75)
Dust commonest	Wheat dust (8.28) House dust (7.08) Cotton dust (1.63)	Cotton dust (6.47) Wheat dust (5.86) Paper dust (3.81)
House dust mite*	12.42	
Fungal spores commonest	<i>Aspergillus fumigatus</i> (4.25) <i>Rhizopus</i> (3.81) <i>Aspergillus tamari</i> (3.38)	<i>Mucor</i> (2.05) <i>Aspergillus fumigatus</i> (2.05) <i>Rhizopus</i> (1.75)
Insects commonest	Moth (33) Mosquito (31.92) Housefly (26.36)	Housefly (25.21) Mosquito (21.11) Moth (19.94)
Kapok cotton	2.18	1.76
Wool*	0.76	
Silk*	1.31	

*These aeroallergens were not tested in 1997-2000 study