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For further information about this article or if you need reprints, please contact:

Mohammad-Ali Assarehzadegan
Department of Immunology,
Faculty of Medicine,
Jundishapur University of
Medical Sciences,
Khuzestan, Ahvaz, Iran

Tel: +98-611-3379755

Sensitization to Common Aeroallergens among Asthmatic Patients in a Tropical Region Affected by Dust Storm

Mohammad-Ali Assarehzadegan, Abdol Hossein Shakurnia and Akram Amini

Asthma morbidity and mortality continues to be an important public health concern in various areas of the world. This study was conducted to investigate the prevalence of sensitization to common aeroallergens among asthmatic patients in Ahvaz city, southwest Iran. One hundred and eleven participants with asthma were selected. Skin Prick Test (SPT) using twenty three aeroallergen extracts was performed on all of the patients. The frequency of sensitization to any allergen was around 90.1%. Among the indoor allergens the most prevalent aeroallergens were mites (56%) followed by cockroach (38.7%) and molds (35%), whilst in the outdoor allergens, weeds (85%) were the most prevalent. Ninety three percent of patients were poly-sensitized and approximately 60% of them were sensitized to more than ten selected allergens. In the conclusion, the prevalence of the skin prick reactivity to weed, tree pollens and mites was noticeably high important in southwest Iran and multiple sensitizations was common. Furthermore, exposure to components of dust storms such as pollens and fungal spores may affect human health directly through allergic induction of asthma.

Key words: Sensitization, aeroallergen, asthma, dust, storm

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Department of Immunology, Faculty of Medicine, Jundishapur University of Medical Sciences, Ahvaz, Iran

INTRODUCTION

Asthma is characterized by chronic airway inflammation and airway hyper-reactivity and also symptoms of recurrent wheezing, coughing and shortness of breath. Morbidity of asthma continues to be an important public health concern in many areas in the world (Cakmak *et al.*, 2011; Gaffin and Phipatanakul, 2009). It is generally accepted that air pollution and exposure to ambient aeroallergens are important factors in increasing the prevalence of asthma in the world (Almogren, 2009; Cakmak *et al.*, 2011).

In a previous study in Ahvaz asthma prevalence was reported 9.8% in 13-14-year-olds and 6.8% in 6-7-year-olds (Shakurnia *et al.*, 2010). However, the prevalence of asthma among various Iranian cities is estimated to range from 2.1 to 7.3%, using the ISAAC questionnaire (Golshan *et al.*, 2002; Masjedi *et al.*, 2004; Rad *et al.*, 2007).

Ahvaz, the capital of Khuzestan province, is a tropical area located in the southwest of Iran. In recent years, dust storms have been an important source of air pollution resources in many countries in the Middle East. The dust phenomenon that occurs in Khuzestan province, grow to be a significant national issue causing heavy pollution and an increase in the frequency of emergency department visits and hospitalizations caused by respiratory allergies, particularly asthma (Keramat *et al.*, 2011; Miri *et al.*, 2007; Waness *et al.*, 2011).

In Khuzestan province the dust storms used to be a common phenomenon for some days in spring and summer but they recently occur almost throughout the whole year. This increase was provoked from persistent droughts, reduced rainfalls, a lower relative humidity environments, loss of canebrake and wars throughout a 28 year period which included: the Iran-Iraq War (1980-1988), the Gulf War (1990-1991) and the 22-year crisis in Iraq (1990-2012) (Keramat *et al.*, 2011).

Due to the high rate of allergy in Iran (Farhoudi *et al.*, 2005; Fereidouni *et al.*, 2009) and lack of data on prevalence of aeroallergens in southwest of Iran after crisis of dust storms in Ahvaz, this study was conducted to investigate the prevalence of positive skin test for various aeroallergens among asthmatic patients in the area.

MATERIALS AND METHODS

Study population and design: This study was conducted as a prospective cross-sectional study on asthmatic patients participating in immunology department of Ahvaz Jundishapur University of Medical Sciences during 2011. One hundred and eleven volunteer participants with

asthma were investigated regarding history, physical examination, pulmonary function test and skin prick test. Moreover, a standard allergy questionnaire requesting demographic data, family history of atopy and respiratory symptoms and the duration of asthma was also administered to each patients and an official agreement from all participants (parents of children) were obtained before the study.

Skin prick test: Skin prick test using 23 common allergen extracts (HollisterStier, USA) was performed on all of the patients. In this study, two mites (*Dermatophagoides pteronyssinus*, *Dermatophagoides farinae*), six molds (*Alternaria-cladosporium* Mix, *Aspergillus fumigatus*, *Cephalosporium acremonium*, *Penicillium* Mix) and a mixture of two different cockroach (*Periplaneta americana* and *Blattella germanica*) extracts were used. Moreover, based on the plant species existing in Khuzestan province, seven different types of weeds (*Amaranthus palmeri*, *Amaranthus retroflexus*, *Kochia scoparia*, *Chenopodium album*, *Salsola kali*, *Plantago lanceolata*, *Artemisia vulgaris*), pollen extracts of four grasses species (*Poa pratensis*, *Cynodon dactylon*, *Lolium perenne*, *Sorghum halepense*) and extracts of four species of trees (*Acacia longifolia*, *Prosopis juliflora*, *Eucalyptus globules*, *Fraxinus americana*) were selected for skin prick testing. Patients with a wheal diameter >3 mm were regarded as positive compared with negative and positive controls. Patients using drugs affecting skin test were excluded from the study.

Total IgE: In the end, enzyme immunoassay method (ELISA) (DIPLUS, Canada) was performed to collect the total IgE serum. Based on the manufacturer's instruction, samples with more than 100 IU/mL IgE was considered as elevated.

Statistical analysis: All data was analyzed by the SPSS software (Version 11.0) (Chicago, USA). Also, Chi-square test was used to compare the variables among the groups. The significance of the differences between means of the male and female participants was analyzed with Student's t-test. The p-values less than 0.05 were considered significant.

RESULTS

In this study, 111 asthmatic patients, 51.4% males and 48.6% females, mean age 30.68 (range 4-66 years) were tested for SPT reactivity (Table 1). The mean duration of their symptoms was 6.91 years and 59.5% of them had positive familial history of atopy (Table 1).

Table 1: Characteristics of patient population

Characteristics	No. of cases
All patients (No %)	111 (100)
Mean duration of asthma (±SD)	6.91±3.99
Gender (No %)	
Male	57 (51.4)
Female	54 (48.6)
Age (mean, range)	30.68 (4-66)
Family history of allergy (No %)	66 (59.5)

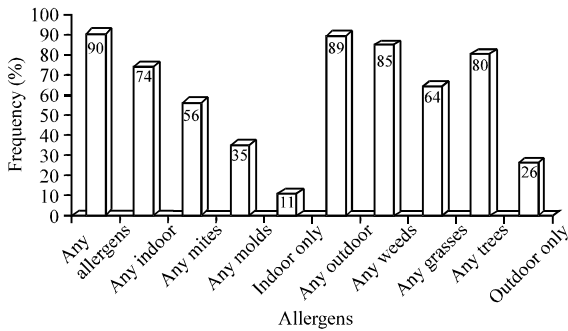


Fig. 1: Distribution of positive skin test response by allergen category among the asthmatic patients with positive skin test

The overall frequency of sensitization to any allergen was 90.1% (100/111) (Fig. 1) and 9.9% (11/111) of patients did not react to any of the tested allergens.

Among the indoor allergens the most prevalent aeroallergens were mites (56%) followed by cockroach (38.7%, Table 2) and molds (35%). In the outdoor allergens the most prevalent aeroallergen category was weeds (85%) followed by tree (80%) and grasses (64%) (Fig. 1). Skin reaction to *Salsola kali* (71.2%) and *Amaranthus retroflexus* (71.2%) were the most common among the selected allergens (Table 2). Among tree pollens, the most prevalent allergen was *Prosopis juliflora* with 64% and the least prevalent was *Eucalyptus globules* with 19.8%.

In the case of positive skin reaction, no significant difference was discovered between men and women. The mean total IgE serum was determined as 154.50 IU/mL. The mean total IgE serum among patients with positive SPT had significantly higher values than patients without positive SPT (167.9 vs. 32.64 IU/mL, $p < 0.001$).

DISCUSSION

Based on the results, among the indoor allergens, allergy to dust mites was relatively high in Khuzestan with a hot and dry climate. Regarding to the optimum condition of 60% humidity and 25°C temperature, high incidence of mite allergy is supposed in humid regions, such as

Singapore (Chew *et al.*, 1999), Malaysia (Liam *et al.*, 2002) and Thailand (Prasarnphanich and Sindhurat, 2005). Unpredictably, this kind of allergy was also found in hot and dry regions, like the Sistan and Baluchestan province of Iran (Khazaei *et al.*, 2003), Qatar (Sottar *et al.*, 2003) and Kuwait (Ezeamuzie *et al.*, 2000). This might be related to the high usage of air conditioners inside the houses which produces a good environment for mites to grow and increases exposure to indoor allergens (Prasad *et al.*, 2009).

In addition, the prevalence of allergy to cockroach was determined to be 38.7%, which is higher than the results of other studies (Fereidouni *et al.*, 2009; Ghaffari *et al.*, 2010). The sensitization to cockroach allergens is one of the most common indoor allergens in some regions with weather similar to Khuzestan (Ezeamuzie *et al.*, 2000; Sottar *et al.*, 2003). It is well defined that exposure to cockroach allergens play an important role in asthma severity in cockroach sensitive patients; therefore cockroaches should be noticed carefully as one of the main source of indoor allergens in patients with asthma.

In our study, sensitization to *Alternaria tenuis* and *Cladosporium cladosporioides* allergens is the most prevalent among the other molds. These fungi are both indoor and outdoor allergens and in the less humid regions; therefore, they are more possible to be associated with asthma (Harmanci *et al.*, 2006; Woolcock and Peat, 2000). The previous publications confirmed that fungi such as *Cladosporium*, *Alternaria* or *Penicillium* are transported by airborne dust (Kakikawa *et al.*, 2009; Ho *et al.*, 2005). This could be a reason for an increase of the emergency department visits of asthmatics patients during dust storms in Khuzestan.

The results of SPT in asthmatics patients showed the high incidence of allergy to plant pollens and the most common were found to be *S. kali* (*Russian thistle*) and *A. retroflexus* (pigweed) pollen with 71.2%. Allergy to members of Amaranthaceae family pollens including *A. retroflexus*, *S. kali*, *C. album* and *K. scoparia* were reported as one of the main causes of asthma and other respiratory allergic diseases in nouibeoring regions (Aburuz *et al.*, 2011; Al-Dowaisan *et al.*, 2004; Assarehzadegan *et al.*, 2009).

Prosopis juliflora (Mesquite) pollen (64%) was the most common sensitizing tree pollen in this study. It is abundant in Khuzestan, where they are planted as shades and ornamental trees or for binding sand. Unexpectedly, despite limited of *Fraxinus americana* (Ash) tree in Khuzestan, the results of this study showed that the ash pollen was the second most common sensitizing tree pollen (47.7%). This could be due to the proved

Table 2: Prevalence of positive skin prick test and total IgE among asthmatic patients

Aeroallergens		Sex			p-value (males vs. females)
Common name	Scientific name	All patients (%)	Male (%)	Female (%)	
Indoor allergens					
Mite	<i>Dermatophagoide s farinae</i>	45.9	49.0	51.0	0.6
Mite	<i>Dermatophagoide s pteronyssinus</i>	43.2	50.0	50.0	0.8
Molds					
Fungus	<i>Aspergillus fumigatus</i>	11.7	46.2	53.8	0.7
Fungus	<i>Cephalosporium acremonium</i>	10.8	50.0	50.0	1.0
<i>Alternaria-cladosporium</i> mix ¹	<i>Alternaria-cladosporium</i> mix	19.8	59.1	40.9	0.4
Penicillium mix ²	<i>Penicillium</i> mix	14.4	56.3	43.8	0.7
House dust					
House dust mix ³	House dust mix	39.0	46.2	53.8	0.4
Cockroach					
Cockroach mix	<i>P. americana</i> + <i>B. germanica</i>	38.7	53.5	46.5	0.8
Outdoor allergens weeds					
Russian thistle	<i>Salsola kali</i>	71.2	57.0	43.0	0.09
Pigweed	<i>Amaranthus retroflexus</i>	71.2	55.7	44.3	0.2
Lamb's quarter	<i>Chenopodium album</i>	69.4	58.4	41.6	0.03
Careless weed	<i>Amaranthus palmeri</i>	67.6	56.0	44.0	0.2
Burning bush	<i>Kochia scoparia</i>	63.1	52.9	47.1	0.6
Mugwort	<i>Artemisia douglasiana</i>	57.7	53.1	46.9	0.7
Plantain	<i>Plantago lanceolata</i>	47.7	52.8	47.2	0.8
Grasses					
Kentucky blue grass	<i>Poa pratensis</i>	53.2	49.2	50.8	0.7
Bermuda grass	<i>Cynodon dactylon</i>	44.1	55.1	44.9	0.5
Johnson grass	<i>Sorghum halepense</i>	40.5	55.6	44.4	0.5
Perennial rye grass	<i>Lolium perenne</i>	29.7	51.5	48.5	1.0
Trees					
Mesquite	<i>Prosopis juliflora</i>	64.0	52.1	47.9	0.8
White ash	<i>Fraxinus americana</i>	47.7	49.1	50.9	0.7
Acacia	<i>Acacia longifolia</i>	45.0	54.0	46.0	0.7
Eucalyptus	<i>Eucalyptus globules</i>	19.8	54.5	45.5	0.8
Total IgE (mean, IU/mL)		156.72	148.21	137.54	0.5

¹The extract includes *A. tenuis* and *Cladosporium (Hormodendrum) cladosporioides*, ²The extract includes *P. digitatum, expansum, glaucum, roseum* and *notatum*, ³Pooled collection containing kapok, feather mix (chicken, duck and goose) and mattress dust

cross-reactivity between pollens of ash and olive (Niederberger *et al.*, 2002; Hemmer *et al.*, 2000), two close taxonomically related trees, which are cultivated in woods and sometimes in parks and gardens throughout the area. Moreover, it is also probable that the sensitization to ash pollen is because of cross-reactivity among pollens of ash and grasses and weeds, as it has been depicted by previous reports (Niederberger *et al.*, 2002). This is also supported by the current results, which revealed a significant correlation between sensitization to pollens of ash and the selected grasses or weeds ($p < 0.001$).

There is no doubt that environmental factors especially air pollution play an important role in the increase of allergies worldwide. In recent years, due to severe geographical and climate changes, the dust storms have turned into a common phenomenon in Khuzestan (Keramat *et al.*, 2011). Yet to this date, there is no information available about the effects of Middle East storms on public health particularly allergic diseases in Khuzestan. However, increasing evidence has accumulated recently that exposure to particulate materials which contained various aeroallergens such as pollens

and fungal spore during dust storms, could increase respiratory allergic diseases (Keramat *et al.*, 2011; Waness *et al.*, 2011; Watanabe *et al.*, 2011). Further studies are required to consider the specific effects of dust storms on hospital visits, admission frequency and the onset and mortality of respiratory allergic diseases in the local residents.

In this study, except sensitization to *C. album*, no significant statistical relationships were found between the positive skin prick test and patient's gender. Moreover, our results also showed no significant differences between the incidence of outdoor allergens and patient's gender.

CONCLUSION

The study revealed that prevalence of the skin prick reactivity to dust mites and weed pollens is significant in asthmatics patients in southwest Iran and multiple sensitizations were unexpectedly common. Further studies are needed to investigate the effects of the current dust storms on the changing patterns of the allergenic pollens and fungal spores patterns in atmospheric environments

and define associations of this phenomenon with the prevalence or exacerbation of respiratory allergic diseases in local residents.

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