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Clinical study of common aeroallergens in Kashan with a hot and dry climate

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Abstract

Objectives: This study represents the first attempt in understanding the prevalence of common allergens in Kashan, based on the clinical data i.e., demographic statistics and available SPTs collected.

Methods: In a retrospective cross-sectional study on 10,000 patients referred to Kashan Asthma and Allergy Clinic from 2006 to 2016, clinical information was extracted through electronic records. Considering risk factors including a family history of atopy, symptoms, smoking, and suitability of sleeping materials, sensitization to 17 aeroallergens was evaluated using SPT.

Results: About 44.6% of patients had simultaneous allergic rhinitis and asthma, while 21.2% suffered concurrently from ocular allergy. The most prevalent outdoor sensitization was against weed pollens (62.3%), specially *Salsola kali* (69.9%), mixed extracts of *Chenopodium album* and *Amaranthus retroflexus* (58.3%) from Chenopodiaceae family, followed by grasses (44.6%), and trees (35.5%). For indoor allergens, cockroach (32.5%) was the most prevalent aeroallergen, followed by mites (27.1%), mold (23.4%), and animal dander (20.64%).

Conclusion: The study showed that reaction to SPT is generally high in Kashan, especially towards weed pollens of the Chenopodiaceae family. Despite her dry climate, the living style in Kashan has traditionally been inclined to keep indoor spaces humid throughout the year and therefore more prone to such indoor aeroallergens as cockroaches, mites, and fungi infestations.

Keywords: Allergen, Allergic Rhinitis, Asthma, Epidemiology, Skin Prick Test.

Introduction

Respiratory allergic diseases are important causes of ill health, imposing considerable concern worldwide on the public well-being and cost of health systems.[1-3] Epidemiological studies and evidence-based guidelines, point to increasing occurrence [4-6] of allergic rhinitis and asthma, being frequently associated amongst 300 million asthmatic and 1.4 billion allergic rhinitis patients.[7-9] Considering the important role aeroallergens play in developing allergic reactions[10] and the co-morbidity involved, a number of studies have reported increased prevalence of these diseases in the hot desert and semi-arid climates such as Iran, with pollen (47%) being the most common allergen sensitizer, especially in hot and dry regions, followed by mites (35%) on both children and adults.[9,11-17]

Geographical identification of allergens influences the diagnosis, prevention, and management of allergic disorders.[18] Incredible climatic variations (mountainous, sub-mountain, and semi-arid deserts) could be encountered, at short distances from cities in arid climates,[19] thereby providing a wide range of pollen-induced outdoor allergens from their diverse vegetation, while excessive application of modern air-conditioning encourages indoor-induced allergens causing variations in the prevalence of mite sensitization primarily due to

differences in populations, lifestyle, and environmental factors.[2,3] Interestingly in the last decade, the increasing trend in allergic disorders has been extended to less polluted cities (in such climates as Kashan), where over 10,000 patients have persistently been referred to specialist asthma and allergy clinic.

Objectives

This study represents the first attempt in understanding the prevalence of common allergens in Kashan, based on the clinical data i.e., demographic statistics and available SPTs collected.

Methods

This is a retrospective consensus study, and the participants in this cross-sectional study included all patients (without age restriction) with allergic symptoms who were referred to the only Asthma and Allergy Clinic in Kashan, a tourism hub in central Iran with very hot summers and a population of 323,000,[20] during 2006 to 2016, where 6650 patients suffering from allergic rhinitis and allergic asthma (seasonal or perennial) registered and attended, 623 of which underwent SPTs. The study was conducted according to good clinical practices and its protocol was approved by the Ethics Committee of Kashan University of Medical Sciences. Demographic data of participants, including a family history of atopy, respiratory symptoms, smoking (be it passive or active), and suitability of sleeping materials (Suitable materials such as cotton and artificial fiber and unsuitable materials like wool and feathers), were also collected for each patient in a questionnaire format. Patients residing outside the greater district of Kashan were excluded from the study. The exclusion criteria include people who are not residents of Kashan city and people with immune deficiency or lung cancer. In addition, incomplete files were excluded from the study.

Based on the clinical records and interviews, 623 patients had opted for SPT using seventeen common allergen extracts (Stallergenes Greer). These include pollen extracts from four different types of weed (*Salsola kali*, a mixture of *Chenopodium album* and *Amaranthus retroflexus*, *Helianthus annuus*, and *Artemisia vulgaris*), two types of grass (mixture of *Agrostis vulgaris, Cynodon dactylon, Bromus inermis, Dactylis glomerata, Festuca elatior, Poa partensis, Avena sativa,* and *Lolium perenne,* and Meadow fescue) as well as five types of tree (mixture of *Acer pseudoplatanus, Aesculus hippocastanum, Platanus vulgaris,* and *Robinia pseudoacacia*, *Pinus sylvestris*, a mixture of *Olea europea, Ligustrum vulgare,* and *Fraxinus excelsior*, *Cupressus sempervirens* and *Morus alba*); allergenic extracts from two types of mite (*Dermatophagoides farina* and *Dermatophagoides pteronyssinus*), one mold (*Alternaria alternate*), one cockroach (*Blatella germanica*) and two types of animal dander (cat and mixture of feathers [Duck, Goose, and Hen]). SPTs were performed under the physician's supervision, by applying allergenic extracts on patients' inner forearms, where epidermis irritation was instigated using disposable prick lancets with results observed after 15 minutes. Next, the diameter of the patient's skin reaction was measured and compared with negative (glycerine saline) and positive (histamine hydrochloride, 10 mg/ml) controls. Skin reactions with the wheal mean diameters of larger than 3 mm or the erythema of more than 8 mm, were taken as positive.

Statistical analysis

Data were analyzed statistically using SPSS software (IBM SPSS Statistics for Windows, Version 16.0. Armonk, NY: IBM Corp). The correlation of quantitative variables was investigated using an independent t-test or Mann-Whitney U test. The relationship of the quantitative variable with more than 2 classes has been investigated using analysis of variance or Kruskal-Wallis. To determine the significant difference between the expected and observed frequencies of the data, Pearson's Chi-squared test, and Fisher's extract test were employed, with $P<0.05$ being considered significant.

Ethical considerations

The study was conducted in accordance with the Declaration of Helsinki. Institutional Review Board approval (code: IR.KAUMS.NUHEPM.REC.1396.22) was obtained.

Results

In this study, data were obtained from 6650 patients suffering from allergic rhinitis and allergic asthma, with a mean average age of 19.90 years old, who attended the specialist clinic during 2006-2016. The number of men and women was almost equal and 58% showed perennial symptoms, while 42% had seasonal symptoms. Of these, 623 (9.4%) patients received SPT tests, among patients with positive results for SPT, perennial and seasonal symptoms were observed in 66.0% and 44.0% of the patients, respectively. Table 1 illustrates the patients'

demographic characteristics as recorded during the clinical assessments.

Out of the patients who received SPT, 269 patients (43.2%) had been diagnosed with allergic rhinitis, 76 (12.2%) with allergic asthma, and 278 (44.6%) with concurrent allergic rhinitis and allergic asthma [Table 1]. Also, of these patients, 63 (10.1%) suffered from ocular symptoms and 132 (21.2%) from skin symptoms. As for their living environment, 76 (13.1%) of the same patients, had a pet in their home, while 97 (16.8%) declared the existence of unsuitable sleeping material in their bedroom. Furthermore, 460 patients (79.4%) had a positive family history of allergic diseases. Table 2 summarizes the data and the associated symptoms.

The patients with only outdoor or only indoor sensitization were 34.1% and 25.6%, respectively. Among the outdoor allergens, the most prevalent category of aeroallergen was weeds (62.3%), while among the indoor allergens, cockroach (32.5%) and animal dander (20.6%) were found to be the most and the least prevalent aeroallergen types, respectively [Table 3].

Following the weeds, the highest sensitization for the outdoor allergens was found towards grass and tree pollens (44.6% and 35.5%, respectively). The prevalence of positive skin test to any allergen, shown in Table 3, indicates that skin reaction to *Salsola kali* was most commonly observed (69.9%) among these patients. Other prevalent weeds included: *Chenopodium album and Amaranthus retroflexus* (58.3%), *Artemisia vulgare* (49%), and *Helianthus annuus* (45.3%). Interestingly, among tree pollen, the most prevalent allergen was Mulberry white (45.7%), while the least prevalent allergen was cypress (21.7%).

As far as indoor allergens are concerned, the most prevalent one belonged to Cockroaches (32.5%) and the least Skin reaction belonged to a cat and feather mixture (20.3%).

The mean age for men and women with positive SPT was 33.69±14.61 and 31.92±13.05, respectively. Among outdoor allergens, however, sensitization to Oleaceae (P=0.011) and Chenopodiaceae (P=0.006), indicating strong evidence and significant prevalence in male allergic patients [Table 3], while for the indoor allergens, no correspondence to gender was noted. As far as correlation to age is concerned, very strong dependences on the prevalence of allergy to Russian thistle, cockroach, and mite2 (P<0.001), and strong evidence on Oleaceae and mite1 (P<0.01), and weak evidence to tree mixture and pine (P<0.05) were observed [Table 4].

Table 1. Demographic characteristics of patients in the population study

Characteristics	No. of cases in general (%)	No. of cases with skin prick test (%)
All patients	6650 (100)	623 (100)
Gender		
Male	3323 (50.0)	339 (54.4)
Female	3317 (49.9)	284 (45.6)
Type of allergy disease		
Allergic rhinitis	1688 (25.4)	269 (43.2)
Allergic asthma	1970 (29.8)	76 (12.2)
Allergic rhinitis & allergic asthma	2992 (44.8)	278 (44.6)
Seasonal	712 (42.0)	90 (44.0)
Perennial	985 (58.0)	175 (66.0)
Age		
Mean ± SD	19.90 ±18.55	18.58±14.89
Median (IQR)	11 (27.25)	13 (24)
Mode	6	6
95% confidence intervals	19.46-20.35	17.40-19.75

Table 2. Manifested characteristics of the patients who took SPT

Symptoms	No. of cases (%)
Respiratory symptoms	378 (60.7)
Cough	314 (50.4)
Wheezing chest	167 (26.8)
Shortness of breath	171 (27.4)
Nose Symptoms	457 (73.4)
Sneezing	202 (32.4)
Runny nose	222 (35.6)
nasal congestion	191 (30.7)
Itching nose	29 (25.4)
Skin symptoms	63 (10.1)
Ocular symptoms	132 (21.2)
Seasonal	90 (44.0)
Perennial	175 (66.0)
Pet	76 (13.1)
No suitable sleeping materials	97 (16.8)
Smoke	98 (16.9)
Family history of allergy	460 (79.4)

Table 3. Prevalence of positive SPT to different aeroallergens by gender

Aeroallergen		All patients (%)	Gender		P value	The risk ratio for men (95% CI)
Common name	Scientific name		Male (%)	Female (%)		
Weeds						
Russian thistle	*Salsola kali*	69.9	54.1	45.9	0.168	0.885 (0.75-1.05)
Chenopodiaceae mixture (Fat hen, Rough pigweed)	*Chenopodium album, Amaranthus retroflexus*	58.3	55.0	45.0	0.006	1.971 (1.16-3.35)
Mugwort	*Artemisia vulgaris*	49	52.0	48.0	0.432	1.176 (0.78-1.76)
Sunflower	*Helianthus annuus*	45.3	58.1	41.9	0.675	1.080 (0.75-1.54)
Any weeds		62.3				
Grasses						
Grasses mixture (Bent grass, Bermuda grass, Bromus, Cocksfoot, Meadow fescue, Meadow grass, Oat grass, Rye-grass, Sweet vernal grass, Timothy, Wild oat, Yorkshire fog)	*Agrostis vulgaris, Cynodon dactylon, Bromus inermis, Dactylis glomerata, Festuca elatior, Poa partensis, Avena sativa, Lolium perenne, Anthoxantum odoratum, Phleum pratense, …, Holcus lanatus*	44.6	53.3	46.7	0.656	0.896 (0.76-1.06)
Meadow fescue	*Festuca elatior*	28.6	50.0	50.0	0.477	0.750 (0.31-1.80)
Any grasses		42.5				
Trees						
Tree mixture (Maple, Horse chestnut, Plane, False acacia, Lime)	*Acer pseudoplatanus, Aesculus hippocastanum, Platanus vulgaris, Robinia pseudoacacia*	38.8	54.9	45.1	0.560	1.049 (0.89-1.23)
Pine	*Pinus sylvestris*	31.8	49.3	50.7	0.236	0.893 (0.74-1.08)
Oleaceae (Olive, Privet, Ash)	*Olea europea, Ligustrum vulgare, Fraxinus excelsior*	38.1	67.5	32.5	0.011	1.620 (1.12-2.34)
Cypress	*Cupressus sempervirens*	16.7	62.5	37.5	0.604	1.190 (0.64-2.19)
Mulberry white	*Morus alba*	45.7	68.8	31.2	0.060	1.866 (0.95-3.66)
Any trees		35.5				
Mites						
Mite1	*Dermatophagoides farine*	28.3	55.8	44.2	0.728	1.029 (0.88-1.2)
Mite2	*Dermatophagoides pteronyssinus*	26.0	53.2	46.8	0.653	0.963 (0.81-1.14)
Any mites		27.1				
Molds						
Alternaria	*Alternaria alternate*	23.4	56.7	43.3	0.558	1.052 (0.89-1.24)
Insects						
Cockroach	*Blatella germanica*	32.5	53.3	46.7	0.464	0.964 (0.82-1.13)
Animal dander						
Cat		20	56.2	43.8	0.656	1.042 (0.87-1.24)
Feathers mixture (Duck, Goose, Hen)		21.3	55.8	44.2	0.765	1.027 (0.86-1.22)
Any animal dander		20.6				

Table 4. Age distribution of patients with positive SPT for various aeroallergens investigated

Allergens	Mean±SD	95% CI	% Frequency of positive skin prick test						*P* value
			<1 yr	1-4 yr	4-17 yr	18-30 yr	31-45 yr	>45 yr	
Russian thistle	19.43±13.99	17.87-20.99	40	39.3	71.7	84.8	82.1	57.9	0.000
Tree mixture	21.07±15.25	19-23.1	23.8	34.0	37.3	34.1	50.5	53.8	0.034
Pine	21.83±16.06	19.21-24.4	30.0	38.3	25.7	29.4	37.6	60.0	0.022
Oleaceae	20.96±15.69	15.88-26.05	-	50	50.0	75.0	74.1	-	0.015
Mite1	21.93±15.77	19.54-24.32	28.1	23.9	21.1	34.3	37.3	35.7	0.016
Mite2	21.74±14.33	19.49-23.99	9.4	26.9	18.1	37.2	33.3	32.1	0.000
Cockroach	22.69±15.37	20.53-24.85	6.7	22.4	29.2	40.1	38.2	60.7	0.000

Discussion

Understanding the allergen's origin is important in managing respiratory diseases in any national health system.[21] Clinical history of symptoms and such diagnostic examinations as skin testing and allergen-specific IgE is commonly used to investigate this.[22] Despite associations being reported between food and respiratory allergens,[23] this was not investigated here as aeroallergens play a far more important role in dry and hot climates. Worldwide, allergic rhinitis which intensifies asthma coexists among 40% of sufferers,[22] and its control is routinely employed to restrain asthma. In this study, 44.6% of patients showed simultaneous allergic rhinitis and asthma, 21.2% also suffered from ocular symptoms and 10.1% had skin symptoms concurrently, indicating perhaps the significant role aeroallergens play in the region's hot and dry climate.

As for the risk factors, amongst many associated with the development and escalation of allergic diseases in various climates,[2,24,25] in line with other worldwide studies reported,[22,26] genetics indicated by family history of atopy was very important (79.4%). Several studies in hot and dry climates [12,27] have highlighted the association of smoking with pediatric allergies; 16.9% of our patients were exposed to smoking, and 50% of them were children. Although there is a slight increase in recent years, pet keeping was not common as only 13.1% of our patients declared exposure to such indoor allergens, and 16.8% did not use suitable sleeping materials.

Plant pollen is the most common type of respiratory allergen reported in middle-east, especially in regions with hot and dry climates.[28] SPT investigations in this study [Table 3], confirmed this and showed that the most prevalent sensitization (69.9%) was against *Salsola kali*, A weed of the Chenopodiaceae family, with more than 60 species identified in the local flora.[29-31] In recent years, the application of Chenopodiaceae in ornamental plants and rushed greening programs in Saudi Arabia, Kuwait and Iran have caused severe sensitization and pollinosis.[32, 33] *Chenopodium album* and *Amaranthus retroflexus* of the same Chenopodiaceae family, known to be important triggers of respiratory allergies,[33,34] grow abundantly in the saline soils of Kashan northern deserts. Interestingly, SPT examination on a mixture of their allergen extracts also showed 58.3% sensitization prevalence.

Considering costs and access challenges, a mixture of allergen extracts is used. For grass SPT examination, a mixture of 12 allergen extracts was used, of which only five from the Poaceae family, have been reported to exist in reasonable abundance in the local flora; i.e., *Cynodon dactylon, Dactylis glomerata, Poa partensis, Avena sativa, Lolium perenne*. For trees, however, a mixture of 5 allergen extracts was used (38.8% prevalence), of which Maple, Horse chestnut, Plane, False acacia, and Lime are rarely seen locally. Interestingly, *Mulberry white* with the highest prevalence of 45.7% is a communal tree in Kashan (an important trade city on the ancient silk road) with a long history in the silk textile industry, while the least prevalent allergen was *cypress* (21.7%), another important tree with its emblem in the core of the classical Kashanian carpet design and Persian arts in general.

Cockroach infestation is often high in tropic and subtropics climates. The corresponding aeroallergen sensitization prevalence reported for Iranian cities [28] ranges from 13.7-32.2 %, averaging 25% nationally. However, despite Kashan's hot and dry climate, this represents the highest indoor aeroallergen prevalence of 32.5% according to SPT results. This might be due to the humid living conditions and ventilation systems employed historically in this old city, where people used to live in the cellars from May to September, and traditionally water ran through open channels and aqueducts, thereby providing a suitable humid environment for cockroaches, mites, and fungus to thrive.

Also, in the last 5 decades, many evaporative coolers have been used to cool the often +50°C outside temperature in the summer and is an important city in the development of traditional medicine, people often used humidifiers or pots to boil off herbal leaves and essential oils in the household space. As indicated earlier, such a living style in a humid indoor environment encourages mite and fungi infestation which in this study, showed a prevalence of 27.3 and 23.4%, respectively. Compared to other Iranian cities,[28] these figures are considerably higher, indicating perhaps the importance of this specific living style.

Regarding SPT outcomes in pets, there are studies suggesting that childhood exposure may help reduce sensitization to such allergens, but sensitization rates to cats and feathers in this study are 20.0% and 21.3% respectively, still significant compared to the other hot and dry. Allergen regions studied.[35]

Finally, it should be noted that in this study, a large number of patients who were referred to the clinic (90%), simply resisted and refused to take SPT examinations. Apart from the increasing treatment costs, depleting public income, and severe national currency devaluation in recent years, this resistance could have roots in old traditional medicine.

Conclusions

This is the first study of its type on the city of Kashan with its hot and dry climate, where 10 years of data from the only specialist clinic was investigated for aeroallergens sensitivity identification, with a view to understanding the allergen's origins. Pollens from such weeds as Chenopodiaceae were found responsible for most respiratory allergic diseases followed by grasses and trees. Despite her hot and dry climate, the humid indoor spaces associated with the specific living style in the household Kashan were prone to cockroaches, mites, and fungi infestations and associated aeroallergens, so for cockroaches, the corresponding aeroallergen sensitization prevalence was found to be highest in the country.

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Competing interests

The authors declare that they have no competing interests.

Abbreviations

Skin prick test: SPT.

Authors' contributions

All authors read and approved the final manuscript. All authors take responsibility for the integrity of the data and the accuracy of the data analysis.

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Availability of data and materials

The data used in this study are available from the corresponding author on request.

Ethics approval and consent to participate

The study was conducted in accordance with the Declaration of Helsinki. Institutional Review Board approval (ethical code: IR.KAUMS.NUHEPM.REC.1396.22) was obtained.

Consent for publication

By submitting this document, the authors declare their consent for the final accepted version of the manuscript to be considered for publication.

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