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Review of Sensitization to Prevalent Allergens in Iran and Their Geographical Distribution

Fardis Teifoori*[1,2], Idoia Postigo[1], Mohammad Abtahi[3], Mehdi Dehghani[4], Jorge Martinez[1]

[1]Department of Immunology, Microbiology and Parasitology, Faculty of Pharmacy and Laboratory of Parasitology and Allergy, Lascaray Research Centre, University of the Basque Country, Vitoria, Spain. [2]Medical Diagnostic Laboratory, Health Pioneers Clinical Laboratory, Vilashahr, Isfahan, Iran. [3]Department of Mycology and Parasitology, School of Medicine, Isfahan University of Medical Science, Isfahan, Iran. [4]Department of Biology. Faculty of Sciences. University of Zabol, Zabol, Iran.

A R T I C L E I N F O

Review Article

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***Corresponding Author:**
Fardis Teifoori,
Department of Immunology, Microbiology and Parasitology, Faculty of Pharmacy and Laboratory of Parasitology and Allergy, Lascaray Research Centre, University of the Basque Country, Paseo de la Universidad, Vitoria, Spain
Email: f.teifoori@gmail.com
Tel/Fax: +989132078793, Fax: +34 945013905

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A B S T R A C T

The prevalence of allergic diseases has been on the rise during past decades. Epidemiological studies have shown that extensive exposure to bio-aerosols causes adverse health effects such as respiratory disorders, allergic reactions and infections. Aeroallergens are allergic airborne particles that disperse from environmental sources over great distances by air currents and ultimately are inhaled by, ingested by, or come into contact with individuals who have had no previous contact with the allergenic agent. The most important bioaerosols in Iran are pollen grains, molds, house dust mites, and animal dander causing many allergic reactions in the country every year. Geographical variation is an important role in the prevalence of allergic diseases, most likely due to different environmental factors. Therefore, identifying geographical and seasonal distribution of allergens not only enables us to warn patients to avoid them but also contributes significantly in the diagnosis, prevention and management of the progress of allergic disorders and provides the possibility of performing immunotherapy. The results of this survey about the most common aeroallergens in different geographic areas of Iran may provide proper prevention activities, vaccine production insights and therefore may reduce the treatment costs for allergic patients.

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The prevalence of allergic diseases such as asthma, atopic dermatitis or allergic respiratory diseases has had a rapid, exponential increase throughout the world over recent decades [1]. According to the epidemiological data from phase III of the International Study of Asthma and Allergies in Childhood (ISAAC), asthma and allergic rhinitis have increased in several regions, including the Asian continent. The prevalence of allergic diseases in Asia varies widely depending on the geographic area; however, there has been an increase in the prevalence from 0.8% to 29.1% for asthma and from 5% to 45% for allergic rhinitis, as communities have adopted modern lifestyles and have become urbanized [2]. There are a variety of sources of major allergenic proteins that cause respiratory allergies, and pollen grains, arthropods (house dust mites and insects), molds, and epithelia are the most important ones. The components of these allergenic sources can play important roles in pathogenesis of allergic diseases [3].

The prevalence of allergic disorders differs in various parts of Iran due to different allergen types that induce the diseases. There is a complex interaction between genetic factors and the environment, especially air pollution, which is an important cause of immunologic sensitization and occupational diseases, such as asthma, rhinitis, hypersensitivity pneumonitis [4] and mycoses [5]. The standard methods for the diagnosis of type I allergic diseases are cutaneous tests, determination of the total and specific IgE levels, the basophil activation test and provocation tests [6]. Moreover, the efficacy of the diagnosis of type I allergic diseases and the subsequent specific treatment depends largely on the knowledge of the distribution of allergens in the areas in question and the consideration of the importance of those region-specific allergens [7, 3]. Accurate allergen selection for provocation tests should be based on their method of production, quality control and standardization proposals. Moreover, the clinical history of the patient's symptoms, age, environmental exposures and characteristics,

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occupational situation and hobbies must be considered in the interpretation of the allergy test [6].

In this paper, considering the importance of allergic reactions that may occur upon exposure to allergens, we provide an extensive overview based on traditional reviews of the prevalence of major aeroallergens and sensitivities to them in different parts of Iran up to 2020. This will be valuable for the prevention and treatment of allergic diseases and might help other related fields such as immunotherapy and vaccine development. For the summary of the reviewed papers see Table1. The assessment of the main findings is discussed in more detail below.

Table1. Summary of reviewed papers on sensitivity to the main aeroallergens in different regions of Iran (supplementary to Table 1 in Teifoori et al. 2018 [8]).

Region	The most Prevalent aeroallergens	Complication	Diagnostic Method	Reference
Bushehr	*Yeast, Aspergillus, Alternaria* and *Penicillium*	Allergic symptoms	Skin Prick Test	[9]
Mashhad	Pollen grains (*Kali tragus* and *Fraxinus excelsior*)	Allergic symptoms	Skin Prick Test	[10]
Birjand	Pollen grains (*Cupressus*, *Quercus* and *Secale*) and Cockroaches Mites *(Dermatophagoides pteronyssinus D. farina)*	Atopic dermatitis	standard taxonomic keys	[11]
Tehran	Pollen grains (Salsola, Festuca and Secale	Allergic symptoms	Multiplex assay (Specific IgE Assay)	[12]
Mashhad	Pollen grains (kali tragus and Amaranthus spp.)	Allergic symptoms	Skin Prick Test	[13]
Ahvaz	Pollen grains (Salsola Kali, Lolium perenn and Salix caprea), mites (Dermatophagoides farina) and cockroaches (Blatella germanica)	Allergic symptoms	ImmunoCAP system	[14]
Tehran	Pollen grains (grasses) and mites	Allergic symptoms	Skin Prick Test	[15]
Zanjan	Mites, molds and cockroach	Allergic symptoms	Skin Prick Test	[16]
Shiraz	Mites (Musca domestica and Dermanyssus gallinae)	Allergic symptoms	Skin Prick Test	[17]
Gorgan	Mites	Atopic Dermatitis	Skin Prick Test	[18]
Shiraz	Cockroach (Blatella germanica), Mites (Dermatophagoides farina)	Allergic symptoms	ELISA assay	[19]
Tehran	Pollen grains (trees, Salsola, Cynodon dactylon and Phleum pratense	Allergic symptoms	RIDA Allergy Screen test	[20]
Firuzkuh	Simulium kiritshenkoi	fever and dermatitis	clinical signs and symptoms	[21]
North of Iran	Dermatophagoides farinae D. pteronyssinus	Allergic symptoms	standard taxonomic keys	[22]

Pollen Grains

Our knowledge of the most common wind-pollinated plants and their local distribution and flowering times is highly valuable for the control of allergic disorders caused by pollen grains. There are approximately 100,000 pollen allergens; however, only anemophilous plants (which produce large quantities of tiny pollen grains that become airborne for days with a density higher than 25 grains per cubic meter of air), can initiate an allergy [23]. The prevalence of allergies to pollen grains has increased in past years, rising up to 86.7% of the allergic patients in different cities, depending on phytogeography, humidity, air pollution and temperature conditions [24-29]. According to local studies, there are three main sources of pollen allergens in Iran. Firstly, the wind pollinated taxa of Amaranthaceae and Asteraceae families, especially Artemisia, Kali tragus (previously Salsola kali), Chenopodium album, Bassia scoparia (previously Kochia scoparia), Amaranthus retroflexus and Amaranthus palmeri.

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Pollen of Kali tragus is the most commonplace aeroallergen in many cities of Iran, inducing highest amounts of allergic rhinitis comparing to other taxa [7, 24, 26, 28, 30-33, 13, 20, 10, 14, 15]. Moreover, Kali tragus shows a close allergenic relationship and cross-reactivity with Caroxylon incanescens (previously Salsola incanescens) [34], stemming from their close evolutionary relationship. Secondly, the anemophilous trees such as most gymnosperms (for example Cupressus sempervirens and Pinus spp.), Phoenix dactylifera, Prosopis juliflora, Fraxinus excelsior, Salix caprea, Ulmus sp., Quercus sp. and Platanus orientalis [11, 14, 35, 36]. The last two trees are planted extensively as street and park trees and may become problematic wherever their pollen density in the air exceeds the thresholds. The pollen of Olea europaea, reported from Zanjan [37], is also a well-known allergen with long-distance dispersal that is produced by extensively planted trees in Rudbar. Thirdly, the widespread non-cereal grasses. According to published papers, the most allergenic grasses in Iran are Phleum pretense, Cynodon dactylon and Lolium perenne, while most likely, there are many other allergenic plants among the grasses that have not been investigated yet [20, 10]. The cross-activating effect is also highly likely to occur among grasses [34].

All studied allergy-inducing plant taxa in Iran are anemophilous and produce tremendous numbers of pollen grains, except for Oxalis corniculata which is a small entomophilous plant, reported as an allergen by Arshi et al. [38]. The pollen grains of Oxalis corniculata may cause an allergy when they are tested directly on the human body; however, under normal conditions, they can hardly induce any sensitivity due to their low pollen density.

Biogeographically speaking, the aforementioned grasses, ruderal plants and cultivated park trees can grow in different climates and cause problems in all parts of the country, although Phoenix dactylifera and Prosopis juliflora are mostly restricted to the southern parts of Iran (Saharo-Arabian region) [39]. As a result, our knowledge of the regional distribution of allergy-inducing plants in Iran can only slightly help to identify the source of the allergens.

Flowering time is a key factor in identifying the allergen sources. Most anemophilous trees bloom in late winter and early spring, while most grasses and C3 plants (the most abundant plants growing in wet conditions) flower during the favorable conditions of the spring to early summer. On the other hand, the studied C4 plants (adapted to hot and sunny areas), including Kali tragus, Caroxylon incanescens, Bassia scoparia, Amaranthus palmeri and Amaranthus retroflexus, flower during early to late summer [40]. Artemisia, with more than 30 species dominating the steppes and desert-steppes of Iran, is another major allergenic genus of plants that bloom from summer until early autumn [41]. As a result, flowering time may be profoundly helpful in recognizing the allergen source, taking proper preventive strategies, and providing more precise management and immunotherapeutic treatment of allergic diseases.

Meanwhile, it should be noted that the data available on allergic pollen grains in Iran are insufficient, and further investigation is highly recommended. For example, exotic wind-pollinated trees such as Ailanthus altissima and Conocarpus erectus are other potential sources of pollen allergens that may be responsible for many cases of pollen allergy in Iran. A recent study has shown a negative relationship between pruning Conocarpus erectus and the number of asthmatic patients who are hospitalized in Ahvaz [42], indicating the potential allergenic role of this ornamental tree.

House Dust Mites and Other Arthropods

Arthropods, such as house dust mites, cockroaches and the larvae of some other insects, are recognized as an important source of aeroallergens causing allergic disease [43]. According to the available sources, contamination by house dust mites and human sensitivity to them usually occur in humid and warm climates of northern and southern parts of Iran [25, 44, 32]. Dermatophagoides pteronyssinus, D. farinae and Euroglyphus maynei are the most common mites in north of Iran, comprising 2/3 of all identified mites [8, 45]. However, D. pteronyssinus has been the most prevalent species among these three mites, with 90% frequency in all samples (94% of pyroglyphids and 60% of all mites) [44]. The presence of dust mites has predominately been reported in the humid regions of South Iran. In these studies, more than 90% of all dust samples contained these mites. The most prevalent mite was again reported as D. pteronyssinus (90% of all mites), and, as in North Iran, D. farinae was the next most important mite [46]. The non-pyroglyphid Cheyletus malaccensis mite from the Cheyletidae family, with a 4% abundance, was also reported in the survey.

It should be mentioned that Southeast and Southwest Iran, such as southern parts of Sistan and Baluchestan [47] Ahvaz [24, 31] and Bushehr [25, 32], also have humid, warm climates like those of the southern coastal zones. In these regions, dust mites are one of the most important aero-allergens, accounting for 43% of the total aeroallergens. D. pteronyssinus and D. farinae are the most prevalent mites in these regions as well [31]. In these regions, dust storms are common phenomena during the spring and summer, with an increasing trend for them to occur in all seasons, due to persistent drought, reduced rainfall, uncontrolled use of water resources in desert areas, the loss of canebrakes and a 28-year period of war, including the Iran-Iraq War (1980-1988), the Persian Gulf War (1990-1991), and the 21-year crisis in Iraq (1990-2011). In addition, the wide usage of air conditioners, which produce suitable conditions for the growth of mites has subsequently increased human susceptibility to indoor allergens. Under the aforementioned climate conditions, people are forced to stay at home, resulting in more exposure to the indoor allergens.

In Mediterranean and semi-arid regions, in accordance with the optimum 60% humidity and 25 °C temperature, a high prevalence of sensitivity to house dust mites (D. farina and D. pteronyssinus, particularly the latter) has been reported in several studies [7, 27, 48-51]. This commonality may be due to the similar geographical characteristics of these regions. On the other hand, Karaj and Yazd, with dry climates and high temperatures in the summer, and Zanjan , with a cold and semidry climate, show lower prevalence of mites[52, 53, 37]. The comparison of the high prevalence of skin reactivity to mosquitos and corn moths in the hot and dry city of Yazd and the high frequency of mite allergies in the humid regions such as North Iran indicates the differences in the prevalence of reactivity to specific aeroallergens in various areas with different climates [49, 53]. The results of a study in Birjand, a semiarid city in East Iran, has shown almost no mites in any of the studied samples [54]. Another study on dust mites in the whole country has indicated that, except for the humid regions in the north, detectable amounts of mites were not identifiable in any other parts of Iran [45]. The authors have suggested that there is nearly no risk of allergies caused by dust mites in other

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parts of Iran due to the extreme seasonal changes of temperature and/or humidity [45]. In summary, the most prevalent mite species are D. pteronyssinus and D. farina; however, the corresponding human sensitivities vary in different parts of Iran. There are four main types of sensitivities to these mites, namely allergic rhinitis, asthma, eczema and urticaria. As expected, the northern regions and south coastal zones have the highest prevalence of sensitivity to mites due to the higher humidity. Studies in Bushehr have shown that allergies to mites account for 88.5% of allergic rhinitis cases, 90.5% of asthma cases, 63.7% of eczema cases and 66.4% of urticaria cases [32, 25]. In Sistan and Baluchestan, the three different studies identified mite allergies as accounting for 86.4%, 89% and 36.5% of rhinitis cases [55, 47, 56].

Sensitivity to mites does not vary significantly in other parts of Iran, ranging from 15% to 45%. There is no reliable, logical relationship between the types of sensitivity and the different species of mites in these regions. For example, in a study performed in Tehran, 21% and 25% of asthma cases were caused by D. pteronyssinus and D. farina, respectively, while 33% and 36% of allergic rhinitis cases were caused by these species [50]. Also, Dermatophagoides farina (21.1%) and Blatella germanica (20.6%) were the most dominant indoor sensitizers in patients with atopy in Ahvaz [14]. The results of a study in three military areas in north of Iran have shown that all military areas are contaminated with dust mites. [22]. Also recently (2019), endotoxin and Der p1 allergen levels in indoor air and settled dust in day-care centers in Tehran have been studied. It has been proved that day-care centers can be an important source of endotoxin and Der p 1 allergen; hence, implementation of proper interventions in these places can reduce their exposure [57].

Another study in 2019 has shown that one of the most common inhalant allergens are mite (35.7%) in north of Iran (Gorgan city, Golestan Province) [18]. A study has been done also on prevalence of allergenic arthropods in domestic dwellings of referrals to an asthma and allergy clinic in Shiraz. The two most numerous species collected have been Musca domestica and Dermanyssus gallinae. The allergies induced in these patients could likely have been attributed to other arthropods that are not considered main allergens in asthma and allergy clinics in Iran. The researchers claimed that health surveillance and prevention of infes¬tation for these arthropods could had an immense impact on the control of the allergenic arthropod community, preven¬tion of respiratory diseases, and personal health in Shiraz [17]. In addition to all this, recently a human case of blackfly fever and dermatitis caused by Simulium kiritshenkoi has been reported in Iran in 2020. In this report a 25-year-old man has been suffered from numerous flies' bites near Namrood River in Firuzkuh County, Tehran Province. Pruritic dermatitis with marked edema, swollen lymph nodes, joints aching, and 40 °C fever have been the symptoms of this allergic reaction [21].

Cockroaches

Roaches have been reported as allergens, and the most common symptoms of sensitivity to cockroaches are skin lesions, respiratory and eye allergies [58]. The allergies due to cockroach aero-allergens are less important in comparison with the allergies caused by dust mites, according to the related studies in Iran, causing mites to be more important arthropods from this point of view. As an example, in a study on asthma, allergic rhinitis and their combination due to mites and cockroaches in North Iran, the prevalence of allergies to dust mites was almost twice as high as that of cockroaches [44]. Cockroaches are ubiquitous, and their distribution in Iran is more generalized than the distribution of dust mites. Unfortunately, there are not any comprehensive studies on the cockroach fauna and distribution in Iran; and local studies are not reliable enough to be mentioned. Studies have shown that asthmatic children with sensitivities to German cockroaches show more severe and perennial asthma [59]. A study based on skin prick tests in Iran has shown that 27% of children under five years old are sensitive to cockroach allergens [60].

Cockroaches are a major source of indoor allergens in Iran, causing between 6 and 35% of allergic disease both in children and adults [28, 26]. In addition, Bemanian et al. [53] have found that more severe asthma could be seen in children sensitive to cockroaches than in those who were not sensitive, with a higher prevalence in girls than in boys. This finding was similar to those in the studies by Mesdaghi et al. [51] and Hosseini et al. [50]. Sensitivity to cockroaches has been reported to be high (25.8%) among patients with atopic dermatitis in Eastern Iran [11]. Another recent study in Shiraz indicated considerable levels of cockroach allergens in dust samples collected from selected schools [19].

Animal Dander

Exposure to animal dander may result in rapid respiratory symptoms in sensitive individuals [61]. A relationship has been found between exposure to animal allergens and an increased in prevalence of asthma and allergies [62]. Sensitivity to cat dander has been found in 13% of asthmatic patients of Iranian populations [59, 50]. However, the prevalence of feather allergies was 78.5%, and 70% in Bushehr and Sistan and Baluchistan Province, respectively [47, 25], possibly due to higher exposure to the allergen sources in these two regions. The lower prevalence of allergies to feathers than to cat dander may result from lower exposure of Iranian populations to the former [8].

Molds

All atmospheric air, whether indoors or outdoors, with some variation contains some fungal spores. The number of different fungal allergens is higher in indoor air than in outdoor air, making it an important health concern for susceptible persons who have a higher chance of responding to fungal allergens. Furthermore, the number of colonies (per plate) cultured from outdoor air has been reported to be greater than that cultured from indoor air [63]. Such a pattern may suggest that housing characteristics allow a more frequent air exchange during the day. This could cause a potential threat to public health because indoor environments are harboring a wide array of allergenic airborne fungal spores, which can be considered the main source of contamination of indoor environments such as homes, offices, and hospitals [63].

Fungal spores act as a marker of the level of atmospheric bio-pollution. It is known that the concentration and prevalence of fungal elements differs according to environmental factors such as geographic location, moisture, temperature, climatic variation, dust and air pollution and that fungal spores play an important role in the increasing prevalence of molds allergies worldwide [9, 64]. According to most studies on fungal air pollution, the most abundant fungal spores in different parts of Iran are Penicillium., Aspergillus, Cladosporidium., Alternaria, Mucor and Rhizopus [65-68]. Similar studies have demonstrated similar prevalence patterns, with some minor exceptions, for 5 fungus taxa, namely Penicillium,

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Cladosporidium, Aspergillus, Alternaria and Zygomycota in the atmosphere of many cities of Iran including Ahvaz [69], Isfahan [67], Shahrekord [70], Qeshm Island [71], Kerman [66], Qazvin [65], Gonabad [68], Babol City and Babolkenar Forest [72], Yazd [73], Semnan [74], and Sari [75]. Obviously, these taxa are common sources of airborne fungal spores. Also from the perspective of sensitization, depending on geo-climatic parameters, these fungal genera are risk factors for the development of asthma and respiratory diseases [49].

As a result of the optimal temperature and maximum humidity conditions, Alternaria spp. have been reported to be the dominant isolated in/outdoor fungi and the most sensitizing aeroallergen in allergic patients with significantly high prevalence (46.1%-82.9%) in Qeshm [71] and Bushehr [25]. Unexpectedly, this allergen is found in hot and dry regions such as Sistan and Baluchistan [47, 56] and Ahvaz [76], which might be associated with the increasing use of air conditioners inside the houses. These conditions provide a good environment for the growth of molds and at the same time increase the chance of people being exposed to the allergens because of more time spent indoors [47]. Additionally, in several studies Aspergillus and Alternaria sensitization have been accounted to be much lower in cold and semi-arid climates [27, 10-12]. However, these findings are in contrast with the results of Payandeh et al. in Mashhad [13] in which allergy to Aspergillus and Alternaria seems to be increasing among allergic patients [7, 30, 10]. In addition, temperature, precipitation, relative humidity and atmospheric CO2 influence the production and concentration of fungal allergens in the atmosphere and, consequently, people's exposure to them [77].

Although these results are somewhat consistent, there are minor differences depending on geography, seasonal patterns, time of day, altitude and climate. For example, most reports have shown that the peak concentrations of fungal spores are recorded during the summer and early fall months [68, 72]. In addition, different isolation rates of fungi recorded in one region may result from the season in which the samplings have occurred, the media used for the isolation of the fungi and the air sampling methods. In most studies, A. alternata is identified as a major aeroallergen that plays a significant role in the induction of allergic diseases [44, 49, 50, 55, 74], although in some studies [7, 27, 37, 15, 14, 78, 16], possibly due to various factors such as lifestyle and culture, its predominance is less marked. However in our previous study [28], no significant frequency (values less than 10%) of A. alternata has been observed. A better understanding of the pattern of fungal allergy occurrence in regions could help us to conclude whether the high prevalence of fungal sensitization is related to high exposure rates or the high potency of fungal allergens. Also there is a greater necessity for studying and evaluating the frequencies of allergy to other allergic fungi other than Aspergillus sp., Cladosporium sp., Alternaria sp. and Penicillium sp. that have significant effect on the individual's health [79]. Therefore, there is a need for more accurate evaluation of fungal aeroallergens and their role in allergy diseases in different parts of Iran.

CONCLUSIONS

Reviewing the available data on allergenic pollen grains in Iran, several points can be emphasized. First, wind pollinated weeds , particularly Kali tragus, Chenopodium album and Amaranthus spp. account for the majority of pollen-induced allergies all over the country [75, 44, 74, 13, 20, 14, 15]. Second, the biogeographical distribution of allergenic plants in Iran rarely helps to distinguish the allergy source, since most of the allergy-inducing plants are either weeds or ornamental plants that are found in many parts of the country. Third, the flowering time can potentially help identify allergen sources and implement subsequent actions. Finally, the impact of the pollen of several local weeds, introduced ornamental and invasive plants, on the health of the Iranian population still remains to be evaluated.

According to available studies, the most prevalent species of mites in Iran are Dermatophagoides farinae and D. pteronyssinus, but the amount of sensitivity to them differs locally. There have been several studies on this subject, and the results of most of those studies have been reasonable for the specific region. Additionally, the ranges of sensitivity in different studies in the same area have been reasonable and logical except in Tehran, the capital, where the range of sensitivity has shown a wide variation from 18 to 48%. This may be due to the multiplicity of studies in this part of Iran. It has been demonstrated that the sensitivity to house dust mites increases in higher humidity and temperature conditions. It is noteworthy that the information gathered from different studies could prove this pattern in Iran, too, and we found a relation between sensitivity to dust mites and different climate conditions or regions in Iran. For example, Yazd has one of the driest climates among the studied cities and consequently has the lowest sensitivity to dust mites (less than 10%), and Bushehr, a port city with a warm and humid climate, has a high range of sensitivity prevalence (up to 90% in a study by Farrokhi et al. (2015) [25]. The other studies in moderate climate regions, in comparison with these two extreme regions, have different ranges of sensitivity that fall in between the sensitivities reported in the two extreme cities. In general, South Iran is the main region for allergies due to house dust mites.

There have been fewer studies about cockroach aeroallergens than house dust mite aeroallergens in Iran. The highest sensitivity percentages to cockroaches have been observed in Ahvaz, Qazvin, Bushehr and some parts of Fars Province, while the lowest sensitivity percentages have been observed in Zanjan, Sari and Mashhad. We could not find any logical relation between these cities according to their climate and percentage of sensitivity to cockroach aeroallergens, since each of these cities has its own specific climate circumstances. Ahvaz is a warm and semiarid area, while Qazvin is a cold, mountainous city. In addition, Sari is a humid, coastal region, but Zanjan is in one of the coldest mountainous parts of Iran.

Higher sensitization rates to some fungal genera including Penicillium, Cladosporium, Alternaria and Aspergillus have been shown in different parts of Iran such as Sari [75], Ahvaz [31, 24, 69, 76, 79, 14, 42], Shiraz [27], Bushehr [25, 32], Esfahan [33], Zanjan [37, 16], Tabriz [80], Sistan and Baluchistan [56, 55, 47] and Semnan [74]. Due to constant contact of these allergens with the immune system and the sensitization reaction, surveying their prevalence is necessary for the prevention of asthma.

Insect aeroallergens are important aeroallergens provoking allergic rhinitis in Yazd City [53]. It seems reasonable to include insect aeroallergens in the routine panel of diagnostic tests in similar geographic areas. In addition, as a first step in the treatment of allergies (allergen avoidance), some guides should be made available for patients with allergic rhinitis regarding the elimination of insect aeroallergens. We suggest that more attention be paid to sensitization to insect

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aeroallergens. Sensitivity to animal dander (dander of cats, dogs or any bird feather) has been reported to be significantly high in Tehran, Kraj, Mashhad, and especially in Sari, Bushehr, Sistan and Baluchistan and Tabriz [25, 47, 50, 59]

Animal feather is also an important common aeroallergen in several regions of Iran [47, 32, 59]. This can be due to both the growing tendency of these populations for keeping pets and domestic animals and the consistency of this kind of allergen in the environment [8, 81].

The results of this review can be beneficial for the management of public health surveillance particularly of asthma, rhinitis, bronchopulmonary conditions, eczema, and urticarial disorders in local regions. It may direct the attention of the regional health systems managers towards several risks to the health of the region's population, when considering environmental protection and management in the context of economics, and urban and infrastructural development.

In brief, this review showed that the prevalence of allergic diseases is to a good degree predictable, geographically and/or seasonally. Detailed knowledge of allergen distribution plays a crucial role for avoiding specific allergens and diagnosing the source of allergens, more accurately in time and space. The latter will facilitate vaccine development and a more precise prescription of allergy vaccines in performing allergen-specific immunotherapy.

Future Directions

There is a need for further studies to define the role and frequency of other allergens, particularly native allergens, in Iran, especially in cities in rural regions.

In addition, according to the documented responses of aeroallergens to climate, there is a need to better understand the relative contributions of different aeroallergens to the development of allergic disorders and the levels of allergen exposure at which the risk for an allergic disorder develops.

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CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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