ORIGINAL ARTICLE
Iran J Allergy Asthma Immunol
June 2021; 20(3):294-302.
Doi: 10.18502/ijaai.v20i3.6332

Airborne Pollens and Their Association with Meteorological Parameters in the Atmosphere of Shiraz, Southwest Iran

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Received: 19 January 2020; Received in revised form: 3 March 2021; Accepted: 11 March 2021

ABSTRACT

Airborne pollen is considered one of the causative agents of hay fever, allergic rhinitis, conjunctivitis, and asthma. We aimed to investigate airborne pollens in the context of Shiraz located in the southwest of Iran and find their association with meteorological parameters.

The survey was conducted from October 2017 to September 2018, using seven days of volumetric Burkard spore trap, located in the center of the city.

A total of 5810 pollen grains/m3 belonging to 15 taxa were identified and recorded. Among them, 73.8% was the tree, while the grass, shrub, and weed constituted 13.56%, 3.5%, and 9.2% of total reported pollens, respectively. The major pollen types were Platanaceae (28.39%), Oleaceae (21.17%), Pinaceae (15.11%), Amaranthaceae (9.29%), and Brassicaceae (8.02%). A higher number of pollen counts and types were recorded in March, followed by September, while it was lower in May. Meteorological parameters were correlated with the monthly pollen counts. Wind speed was found to have a positive correlation with Platanaceae concentration. The significant correlation between pollen concentration and the temperature was positive for Poaceae, Amaranthaceae, and Plantaginaceae and negative for Rosaceae, Oleaceae, and Ulmaceae. Poaceae and Amaranthaceae were negatively correlated with humidity and positively with Rosaceae, Oleaceae, and Plantaginaceae. A negative correlation was found between rainfall and Poaceae and Amaranthaceae, while Plantaginaceae had a positive correlation with this parameter.

The results of this study may be helpful for allergologists in the diagnosis and treatment of airborne allergic disorders due to pollen grains.

Keywords: Hypersensitivity; Meteorological factors; Pollen

INTRODUCTION

Pollen is a major aeroallergen, which is released during pollination of the plants into the atmosphere and is considered as one of the main causative agents of several chronic conditions including allergic rhinitis,

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allergic asthma, and allergic conjunctivitis.[1] It is approximated that about 40% of allergic patients have been affected by pollens.[2] Such allergic conditions are associated with an economic burden regarding the cost of treatment and medications, and indirect costs from lower workplace productivity, adverse school performance in children, and reduced quality of life. In this regard, various studies have tried to identify the most dominant airborne pollens in each area worldwide, and also some clinical studies have found its association with allergic diseases to help allergologists accurately diagnose the disease and treat the patients.[3,4] In Iran, such clinical studies have been performed in various cities including Shiraz,[5] Tehran,[6] Karaj,[7] Mashhad[8], and Ahvaz.[9] In these studies, White or European Ash tree (*Fraxinus Americana* L. and *Fraxinus excelsior* L.) and Sycamore tree (*Platanus orientalis* L.) were identified as the most common airborne allergens.[10]

Meteorological factors such as temperature, humidity, rainfall, and wind speed have a great impact on the presence and concentration of airborne pollens, their release, transport, and dispersal.[11,12] As these parameters vary throughout different areas and years, it is obvious that airborne pollen concentration and composition change according to the local weather and flora. Therefore, it seems to be essential that the pollen composition of each area be surveyed regularly and also the most dominant pollens be introduced to manage seasonal allergies. Besides, the most important type of airborne pollens recognized by such study can be used to run some diagnostic tests such as skin prick tests, serum IgE levels, and nasal allergen provocation tests (NPTs), and also initiate appropriate therapies. Few studies investigated airborne pollen grains in Iran, compared with other countries.[6,13,14] Two studies have been performed by Amin et al[13] and Moghtaderi et al[15] to survey airborne pollens over the context of Shiraz, southwest Iran. As Shiraz is well-known for its gardens and pollen aeroallergens are one of the important causes of allergic rhinitis in this city (92.4%),[5] regular identification of the most important airborne pollen would be beneficial to both the allergists and their patients.

In this study, we aimed to document monthly pollen counts to identify the most predominant pollen grains and correlate them with some meteorological parameters in the context of Shiraz city in October 2017-September 2018.

MATERIALS AND METHODS

This study was performed in Shiraz, the capital city of Fars province, southwest of Iran. Shiraz is built in a green plain at the foot of the Zagros Mountains 1500 meters above sea level. The climate of Shiraz has distinct seasons and is overall classified as a cold semi-arid climate though it is only a little short of a hot semi-arid climate or a hot-summer Mediterranean climate.

Sampling was performed for one year from October 2017 to September 2018 using Burkard's Seven Days Volumetric Spore Trap. The machine was placed on the roof of an office building in the center of the city at a height of 10 meters above ground level. The location of installment allowed for the capture of pollen grains prevalent in the greater part of Shiraz. A wind vane is attached to the sampler head, so the head can rotate. The air was drawn into the sampler through a 14 mm × 2 mm orifice designed in the machine and the airborne particles were attached to the adhesive Melinex tape. The Melinex tape with a thin layer of 10% Gelvatol was applied to the round drum. After 7 days Melinex tape was removed and stained with safranin. The data were collected for one year and studied according to the guidelines of the manual by Lacey and West.[16] Then, the slides were scanned using an optical microscope (Nikon's ECLIPSE E200-LED) at a magnification of 40X, and the images were captured by an attached digital camera. Pollen grains were identified according to the general indicates that exist to prove pollen consistency of particles. Pollens were identified based on the criteria of multi-unit, size, and shape. The total daily counts were converted into the number of pollen grains per cubic meter of air (pollen/m^3).

Meteorological data for one year (October 2017-September 2018) including temperature, relative humidity, rainfall, and wind speed were collected from Fars meteorological department (Table 1). This study was approved by the local Ethics Committee of Shiraz University of Medical Science (IR.SUMS.MED.REC. 1396.S165). The correlation between monthly pollen grains and meteorological parameters was calculated using the Spearman test. SPSS 16.0 software was used for all statistical analyses.

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RESULTS

A total of 5810 pollen grains from 15 taxa were trapped and identified in Shiraz, Iran, from October 2017 to September 2018. The most abundant pollens included *Platanus* sp. (28.39%), *Fraxinus* sp. (21.17%), *Pinus* sp. (15.11%), *Amaranthus* sp. (9.29%), and Brassicaceae (8.02%) (Table 2). The pollen grains were divided into four groups: tree, grass, weed, and shrub. The most important part of pollen grains was a tree (73.8%), while grass, weed, and shrub constituted 13.56, 9.2, and 3.5% of the total reported pollens, respectively. Tree and grass types reached their maximum counts in March, weed in September, and shrub type in January (Figure 1).

Table 1. Air temperature, rainfall, wind, and humidity in Shiraz, Iran, from October 2017 September 2018

Month	Mean temperature (°C)	Mean humidity (%)	Mean rainfall (mm)	Maximum wind speed (ms^{-1})
October	21.1	27	0	15
November	14.7	36	16.3	16
December	8.8	58	30	10
January	8.2	48	5.9	12
February	7.5	38	1.2	17
March	12.7	48	37.8	18
April	17.3	38	22.8	16
May	20.2	42	38.7	19
June	27.5	21	0.5	13
July	29.6	18	0	13
August	30	24	0	13
September	28	26	0	12

Table 2. Monthly pollen grain counts in Shiraz, Iran, from October 2017 to September 2018

Taxa	Oct	Nov	Dec	Jan.	Feb.	Mar	Apr	May	Jun	Jul	Aug	Sep	Total	%
Poaceae	7	7	1	1	1	3	6	1	8	13	7	16	71	1.22
Solanaceae	12	121	8	2	0	0	0	0	0	7	5	7	162	2.78
Sapindaceae	3	0	0	0	3	7	11	1	0	3	0	38	66	1.13
Asteraceae	35	3	2	0	0	1	0	0	0	0	5	15	61	1.04
***Amaranthus* sp.**	21	6	1	1	1	2	0	0	1	13	78	416	540	9.29
Cupressaceae	19	3	1	7	42	17	0	0	0	1	3	1	94	1.61
Brassicaceae	3	9	6	78	1	357	1	0	0	2	5	4	466	8.02
Asclepiadaceae	0	2	0	0	0	0	0	0	0	39	0	0	41	0.70
Rosaceae	0	11	14	106	10	19	14	0	1	10	3	3	191	3.28
***Pinus* sp.**	0	2	5	3	14	707	107	1	2	17	14	6	878	15.11
***Fraxinus* sp.**	0	0	2	1	22	1183	21	0	0	1	0	0	1230	21.17
Ulmaceae	0	0	0	6	131	83	14	0	0	0	0	0	234	4.02
***Platanus* sp.**	0	0	0	0	8	1618	24	0	0	0	0	0	1650	28.39
Juglandaceae	0	0	0	0	0	70	28	0	0	0	0	0	98	1.68
Plantaginaceae	0	0	0	0	0	0	0	0	0	10	3	15	28	0.48
Total	110	181	41	205	242	4109	252	9	18	124	126	526	5810	
%	1.85	3.04	0.69	3.45	4.07	69.14	4.24	0.15	0.3	2.09	2.12	8.85	-	100

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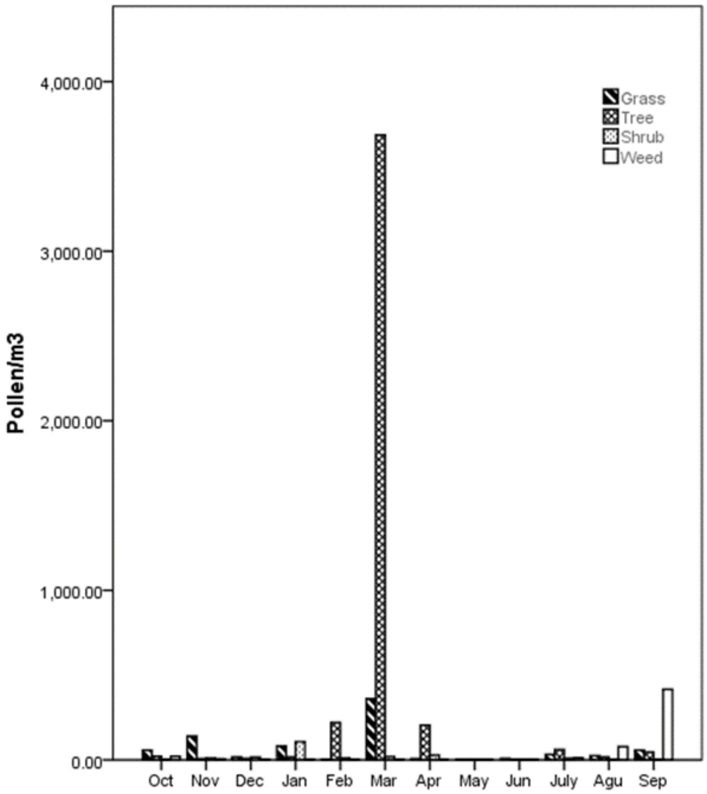

Figure 1. Monthly variation in grass, tree, shrub, and weed pollens in the atmosphere of Shiraz, Iran, from October 2017 to September 2018

A higher number of pollen counts was recorded in March (69.14%) followed by September (8.85%), while it was minimum in May (0.15%) (Table 2). The main pollen season, duration, peak day, and concentration in a peak day are summarized in Table 3. Most pollen grain peak days were reported between 10- 21 March with 1801 pollen/m^3, 357 pollen/m3 for Brassicaceae on 10^{th} of March; 118pollen/m3 for *Pinus* sp. on 12^{th} of March; 778 pollen/m3 for *Fraxinus* sp. on 15^{th} of March; 514 pollen/m3 for *Platanus* sp. on 14^{th} of March, and 34 pollen/m3 for Juglandaceae on 21^{st} of March. All former pollen grains were tree type, except for Brassicaceae which belonged to Grass-type (Table 3).

Spearman test was performed to determine the relationship between pollen count and meteorological parameters (Table 4). There was a significant correlation between pollen grain counts of 7 taxa and meteorological parameters in Shiraz for a defined period, while no correlation was observed between total pollen counts and meteorological factors. The significant correlation between pollen concentration and the temperature was positive for Poaceae, *Amaranthus* sp. and Plantaginaceae and negative for Rosaceae, *Fraxinus* sp. A negative correlation was found between Poaceae and *Amaranthus* sp. and humidity, while it was positive for Rosaceae, *Fraxinus* sp. and Plantaginaceae. Rainfall was negatively correlated with Poaceae, *Amaranthus* sp., and positively with Plantaginaceae. A Wind speed showed only a positive correlation with Plantaginaceae. According to this data, Poaceae, *Amaranthus* sp. raised to the maximum value in conditions with high temperature and low humidity and rainfall, while Plantaginaceae need high temperature, humidity, and rainfall. Rosaceae, *Fraxinus* sp. reached maximum concentration in a cool and humid climate. High wind speed in cool and humid conditions was preferable for Platanaceae.

Table 3. Main pollen season, duration, peak day, and concentration in a peak day of 15 taxa in Shiraz, Iran, from October 2017 to September 2018

Taxa	Main pollen season	Duration of pollen season (Days)	Date of peak day and value (pollen/m^3)
Poaceae	21 Jul.31 Jul.	11	23 Jul. (5)
Solanaceae	4 Nov.11 Nov.	8	9 Nov. (34)
Sapindaceae	11 Sep.18 Sep.	8	11 Sep. (28)
Asteraceae	17 Oct.23 Oct.	7	18 Oct. (15)
***Amaranthus* sp.**	25 Sep.2 Oct.	8	28 Sep. (38)
Cupressaceae	7 Feb.15 Feb.	9	10 Feb. (11)
Brassicaceae	4 Mar.11 Mar.	8	10 Mar. (357)
Asclepiadaceae	11 Jul.21 Jul.	11	16 Jul. (28)
Rosaceae	16 Jun.25 Jun.	10	16 Jan. (37)
***Pinus* sp.**	11 Mar.18 Mar.	8	12 Mar. (118)
***Fraxinus* sp.**	11 Mar.18 Mar.	8	15 Mar. (778)
Ulmaceae	24 Feb.4 Mar.	9	28 Feb. (24)
***Platanus* sp.**	11 Mar.18 Mar.	8	14 Mar. (514)
Juglandaceae	18 Mar.26 Mar.	9	21 Mar. (34)
Plantaginaceae	21 Jul.31 Jul.	11	21 Jul. (8)

Table 4. Correlation between meteorological parameters and pollen count in Shiraz, Iran, from October 2017 to September 2018

Taxa	Temperature		Humidity		Rainfall		Wind speed	
	R	Sig	R	Sig	R	Sig	R	Sig
Poaceae	0.807	**0.001**	-0.871	**000**	-0.688	**0.007**	-0.277	0.192
Solanaceae	0.193	0.274	-0.175	0.293	-0.218	0.248	-0.475	0.059
Sapindaceae	0.102	0.376	-0.066	0.419	-0.333	0.145	0.299	0.173
Asteraceae	0.314	0.161	-0.137	0.336	-0.259	0.208	-0.253	0.214
***Amaranthus* sp.**	0.563	**0.028**	-0.549	**0.032**	-0.518	**0.042**	-0.346	0.135
Cupressaceae	-0.409	0.094	0.193	0.274	0.029	0.464	0.124	0.351
Brassicaceae	-0.298	0.173	0.412	0.92	0.240	0.226	-0.275	0.194
Asclepiadaceae	0.226	0.240	-0.415	0.090	-0.100	0.378	0.014	0.483
Rosaceae	-0.613	**0.017**	0.576	**0.025**	0.277	0.191	-0.164	0.306
***Pinus* sp.**	-0.025	0.470	0.030	0.463	-0.193	0.274	0.073	0.411
***Fraxinus* sp.**	-0.636	**0.013**	0.542	**0.034**	0.237	0.230	0.191	0.276
Ulmaceae	-0.670	**0.009**	0.476	0.059	0.177	0.291	0.408	0.094
***Platanus* sp.**	-0.441	0.076	0.359	0.126	0.124	0.351	0.566	**0.028**
Juglandaceae	-0.204	0.262	0.340	0.140	0.111	0.365	0.437	0.078
Plantaginaceae	0.725	**0.004**	0.626	**0.015**	0.600	**0.020**	-0.413	0.091
Total pollen count	-0.218	0.497	0.304	0.337	0.462	0.130	0.384	0.217

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DISCUSSION

Knowledge about the airborne pollen composition and its association with allergic disease is necessary for each area due to increasing allergic respiratory diseases worldwide. In this study, we investigated airborne pollen grains and their relationship with meteorological factors in Shiraz, Iran, in the period from October 2017 to September 2018.

We divided the airborne pollen into four categories. Tree-type pollens were most dominant in Shiraz for a defined period. Trees have been reported as the main source of pollen, because of their large pollen production per anther and inflorescence.[17] Consistent with our data, Moghtaderi et al[15] reported tree as the paramount pollen type in Shiraz during 2012. In addition, this type of pollen was more prevalent in other areas of the world such as Beirut, Lebanon,[18] Allahabad, India,[19], and Sivrihisar, Turkey.[20] In this study, tree-type pollens increased from February to April and reached their maximum concentration in March, as reported by Moghtaderi et al[15] in Shiraz and Shafiee et al[14] in Tehran. However, Amin and Bokhari[13] recorded tree pollen peaks from April to May in Shiraz. Change in the peak time of tree-type pollens may be related to the effects of climatic changes in the atmosphere of Shiraz during these years.

In our study, March followed by September had the greatest pollen counts in Shiraz from October 2017-September 2018. March was also recorded as the month with the highest pollen numbers in Shiraz during 2012 consistent with others areas worldwide such as Allahabad, India,[19,] and Beirut, Lebanon.[18] In the current study, most predominant pollens including *Platanus* sp., *Fraxinus* sp., *Pinus* sp. and Brassicaceae reached their maximum levels in March, while in Moghtaderi et al.'s (2012) study increased pollen levels in March were mainly related to *Buxus* sp., *Fraxinus* sp. and Cupressaceae.[15]

In the current study, *Platanus* sp. was recognized as the most prevalent pollens in Shiraz during a defined period *Platanus* sp., London plane tree, is a universal street and courtyard shade tree. Because of its resistance to dust, diseases, and environmental pollution, it is widely planted in cities worldwide, especially in North America, Southwest Asia, and southeast Europe. The plants grow in cool situations in temperate climates and are frequently found on the edge of rivers and its flowering is from April to mid-June.[21] *Platanus* sp. was also detected as one of the most frequent spring pollens in the atmosphere over California, Spain, and, China.[22,23] This pollen has been introduced as one of the important aeroallergens by clinical studies regarding their reactivity with serum IgE of allergic patients.[22,23] Pla a1 and Pla a2 are two important allergens of *Platanus* sp..[23-25] In Iran, this pollen was reported as aeroallergens based on the prick test performed in some regions like Isfahan,[26] Mazandaran,[27] Sari,[28] and Mashhad.[29]

Fraxinus sp. or Ash tree, pollen was identified as the second most prevalent pollen grains in our study. As is widely distributed in Europe, Asia, and North America and has been suggested as a potent allergen source from March to May.[30] In Shiraz, the count of this pollen increased from February and reached its maximum concentration in March.[15] Ash has also been detected as the predominant aeroallergen pollens based on the prick test in countries located in the Middle East such as Lebanon,[18] Turkey,[31] and some areas of Iran such as Isfahan,[26] Ahvaz,[9] Khorasan Razavi,[8] Mazandaran,[27] Sari,[28] and Shiraz.[15] Fra e1 has been described as the main allergen in ash pollen.[32]

Pinus sp. was also detected as the most prevalent pollen in Shiraz in March like other countries for example Turkey[20] and Spain.[33] *Pinus* sp. pollen allergy has been generally considered to be rare and clinically insignificant; however, the allergenic significance of this pollen has been documented from different areas of Iran including Tehran,[14] Shiraz,[5] and Mashhad,[8] and various regions of the world.[34,35]

Amaranthus sp. pollen grains were also abundant in Shiraz during September 2018. The genus *Amaranthus* is a summer annual weed that consists of several species. The pollen produced by the plants in these genera acts as an allergen for many people, leading to bouts of hay fever. Immunoglobulin E (IgE)-mediated allergy to pollens from the *Amaranthus* sp. is common in semi-desert countries such as Saudi Arabia, Iran, and Kuwait.[36-38]

Brassicaceae were the most prevalent pollen in our study. Aerobiological surveys in different areas of the world have quantitated its incidence and reported this pollen as predominant airborne pollen similar to our results.[39] Also, this pollen showed reactivity with IgE of allergic patients.[40,41]

Weather and climate are important factors regulating pollen emission and presence in the air. However, their influence is temporally and spatially variable. In this study, the correlation between the monthly pollen count of each type and meteorological factors was analyzed. Wind can affect the concentration of the pollen through some means: removing pollen grains locally emitted, transporting pollen grains from different sites, and re-suspending processes. In the current study, among all taxa, only *Platanus* sp. was positively correlated with wind speed that was consistent with other studies.[12,42] In general, available information indicates that airborne pollen abundance and diversity tend to be positively correlated with temperature, and negatively with humidity and rainfall in a variety of contexts;[10,13] however, some studies reported a positive correlation between pollen count and temperature and humidity.[11] In this study, both relative humidity and rainfall were positively correlated with Plantaginaceae count but negatively correlated with Poaceae and *Amaranthus* sp. The negative correlation between rainfall and humidity and Poaceae and *Amaranthus* sp. levels is consistent with Moghtaderi et al's[15] study and its positive correlation with Plantaginaceae is concordant with Rutherford et al.'s results,[2] while Tormo et al[3] found significant negative correlations between these factors. In the current study, the temperature was positively correlated with 3 taxa (Poaceae, *Amaranthus* sp., and Plantaginaceae) and negatively with 3 taxa (Rosaceae, *Fraxinus* sp., and Ulmaceae). A positive correlation between this taxa and temperature has also been discussed by other studies.[1,15,19,13] The negative correlation between *Fraxinus* sp. and the temperature was also documented by Moghtaderi et al during 2012 in Shiraz.[15]

In conclusion, as airborne pollen is one of the most important causes of allergic reactions, which affect many people worldwide, identification of the prevalent pollens by aerobiological studies seems to be essential in each area. Such studies can help allergologists know the common pollens in each area and their seasonal air dispersion. Since the pollen composition is closely related to meteorological parameters, which vary throughout years, comparative analysis of data from several consecutive years and preparation of pollen calendars of Shiraz are suggested to be done in future research. Besides, it is recommended that clinical studies should be conducted to evaluate the allergenicity of the most prevalent pollens reported in this study.

CONFLICT OF INTEREST

There is no conflict of interest between the authors.

ACKNOWLEDGEMENTS

This work was supported by Shiraz University of Medical Science under grant number 95-01-35-13925. The authors would like to thank Shiraz University of Medical Sciences, Shiraz, Iran, and also the Center for Development of Clinical Research of Nemazee Hospital and Dr. Nasrin Shokrpour for editorial assistance.

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