Evolution of the incidence of *pollen grains* and sensitivity to pollen in the city of Elche (Spain)

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Summary

Background: **Environment-mediated pollen production varies over time and space, influencing pollen exposure risk and ultimately patient sensitization trends. In order to assess temporal variation of pollen incidence and patient sensitization, we set up a pollen incidence and patient sensitization survey in the city of Elche, Spain, over a 10-years interval.**

Methods: **Pollen counts were obtained from a Burkard-type collector located in the city of Elche. We studied consecutive patients attending the outpatient consulting room at the Elche Hospital for suspected pollinosis (276 in 2005), and compared observed trends with cases from 1995 (200). Skin tests were performed for most of the common pollen in our area.**

Results: **The total pollen count increased by 41% from 1995 (13,219) to 2005 (22,854). There were significant counts differences between 1995 and 2005 in *Olea europaea* (2,018 vs. 4,433), *Phoenix dactylifera* (3,130 vs. 3,891), and Cupressaceae (1,212 vs. 3,115). The differences between sensitization to pollen in both years were mainly for those in relation to *Olea europaea* (51.4% vs. 74.9%), *Salsola kali* (53.7% vs. 71.8%), *Parietaria judaica* (10.3% vs. 21.5%), *Phoenix dactylifera* (5.6% vs. 22.3%), *Plantago lanceolata* (17.8% vs. 38.5%), and Poaceae (47.7% vs. 44.1%). The percentage of monosensitized patients was similar in both years, 16% in 1995 and 17% in 2005.**

Conclusion: **Increased pollen counts in the environment may have led to increased sensitization to pollen. Possible causes may be due to changes in the weather, although the improvements of the extracts used in skin testing, increased air pollution, and/or climate change are factors to consider.** ***(Asian Pac J Allergy Immunol 2015;33:196-202)***

Keywords: *airborne pollen, pollinosis, rhinitis, asthma, mediterranean weather, cheno-amaranthaceae, date palm pollen.*

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Introduction

Pollen is one of the most important sensitizing aeroallergens today. Its presence depends upon the type of vegetation, soil type, and climatic conditions.[1]

The numbers of persons sensitized to pollens have been increasing in recent decades, especially in large cities and industrial areas.[2]

The city of Elche is located within the Vinalopó valley in the province of Alicante, and sharing the same Mediterranean climate, albeit drier due to scarce precipitation, than the rest of the Mediterranean coast. It is a region that boasts great numbers of Oleaceae, Chenopodiaceae, and specifically within the city of Elche, many Palmaceae. It is atypical within the Mediterranean zone because it has fewer Urticaceae than neighboring areas.[3]

Knowledge about climate change has evolved greatly over the last 10 years, and according to some authors, changes in pollen production as well as pollen sizes are already beginning to be observed.[4,5] Increases in respiratory diseases seem to be related to air pollution.[6] It damages mucous membranes and facilitates access to inhaled allergens, favoring IgE sensitization.[7] Because of this, learning about changes in pollen sensitization in patients and what variables may be involved over time is warranted.

The objective of this work was to assess the current situation of pollen counts within Elche and the incidence of pollen sensitization as well as comparing these results with a previous study conducted 10 years ago within the same city, following a very similar methodology.

Methods

A descriptive observational study comparing pollen counts and pollen sensitization to a previous study performed in 1995.[3]

Pollen count

Pollen count data during the study period were obtained from the Elche pollen station that belongs to the Aerobiology Committee of the Spanish Society of Allergology and Clinical Immunology (SEAIC).[8] A Burkard Spore Trap (Burkard Manufacturing Co. Rickmansworth, Hertforshire, U.K.) with a flow rate of 10 L/min was used. It was placed on the roof of the Specialty Center of the Valencian Health Service located in the west central portion of the city, an area free from surrounding parks but not very far from a cemetery, at a height of approximately 20 meters above ground level. The results are expressed in pollen concentration (grains of pollen/m^3).

Glycerin jelly was used as impactor, with basic fuchsine dye, as in the 1995 study.[3] Four longitudinal readings were taken with a 400x Nikon microscope that provided averaged weekly data for the following taxa studied: *Pinus sp*., Cupressaceae, *Platanus sp*., *Quercus sp*., Betulaceae, Moraceae, Urticaceae, Chenopodiaceae-Amaranthaceae, Polygonaceae, Oleaceae, *Artemisia sp*., Poaceae, and Arecaceae or Palmaceae.

Sensitization to Pollens

A consecutive sample was obtained from 276 patients who attended consultation for allergies at the Elche Hospital in 2005 due to rhinitis and/or asthma. The study was approved by the Elche hospital ethics committee. All patients provided signed informed consent. Skin testing was performed using the skin prick method proposed by the European Academy of Allergology and Clinical Immunology.[9] We used the battery of commercial extracts from ALK-Abelló, Madrid, Spain, that included the most common pollens, such as *Cupressus arizonica*, *Chenopodium album*, *Artemisia vulgaris*, *Lolium perenne*, *Phleum pratensis*, *Olea europaea*1, *Plantago lanceolata*, *Platanus orientalis*, *Parietaria judaica* and *Salsola kali*, and mites, cat and dog dander. Palm pollen (*Phoenix dactylifera*) was collected from palm trees in Elche, prepared and standardized by the Bial-Aristegui laboratory. Prick tests were performed using 1 mm lancets (DHS prick lancet) in patient's both forearms, for which readings were taken after 10-15 min. All skin test series included histamine hydrochloride (10 mg/ml) and physiological saline as positive and negative controls, respectively. The only reactions considered positive were those producing a wheal that was equal to or larger than that of the histamine.

Climate values

The Spanish National Meteorological Agency (AEMET) provided temperature and rainfall data for La Marina de Elche weather station (station 7263), located at 38.0845''N, 00º38'28"W, and 20 m.a.s.l., which is within the Elche city limits.

Statistical analysis

Descriptive statistics such as, percentages as well as graphical representations were used to assess trends. Mean differences were assessed using t-tests. Differences for which $p < 0.05$ were considered significant. All statistical analyses were performed using SPSS version 15.0 for Mac (SPSS Inc., Chicago, IL, USA).

Pollen calendars were produced following the technique proposed by Spieksma, that of 10-day mean pollen levels.[10]

Results

Pollen grains

In 2005, the highest pollen concentration occurred from the second half of March until the second half of June, with three maxima in March, April, and May (Figure 1). An outbreak also appeared in the month of September, with the months of November and December having the least pollination.

Total pollen values (Figure 1) were significantly higher ($p < 0.01$) in 2005 (22,854) with respect to 1995 (14,219). The onset of peak values was delayed from the second half of February until March. The pollen peaks were higher in 2005 (924 p/m^3) than in 1995 (438 p/m^3).

Figure 2 shows the pollen calendar for 2005. Among the pollens of interest several pollen types are standing out:

Pinus sp: maximum peaks between March and April, with an increase in late June.

Cupressaceae: sharp maxima in the second half of March. A nearby cemetery may have influenced these levels.

Quercus sp: maximum levels from April to June.

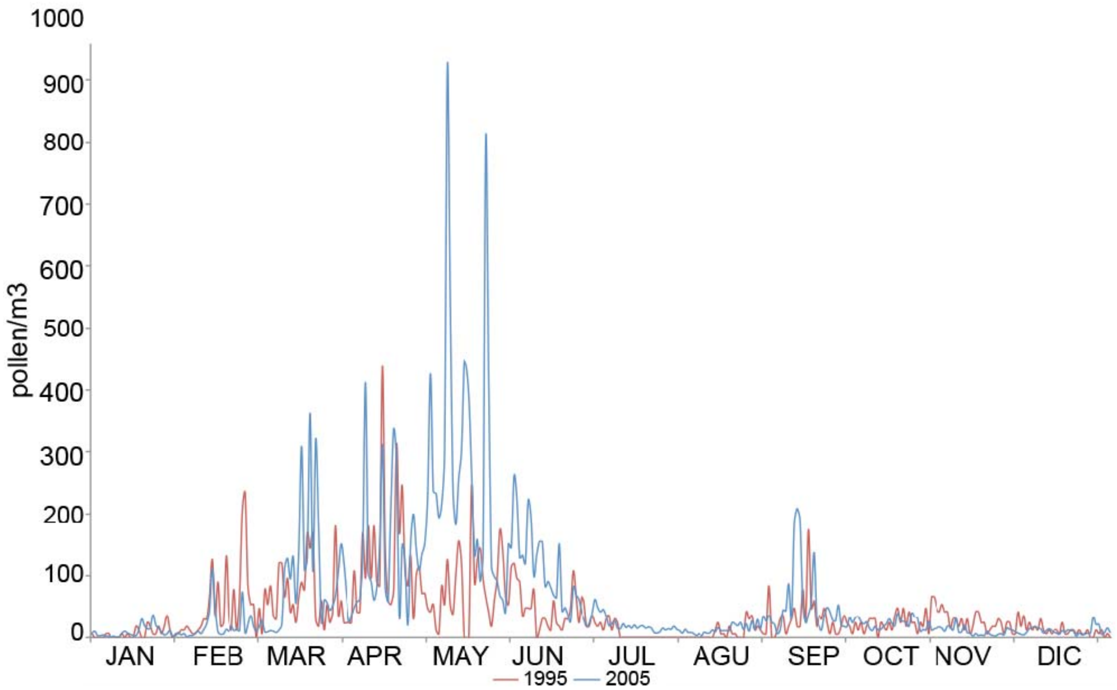

Figure 1. Pollen concentrations in the years 1995 and 2005. The figure shows the graphic representation of total daily pollen concentrations in 1995 and 2005.

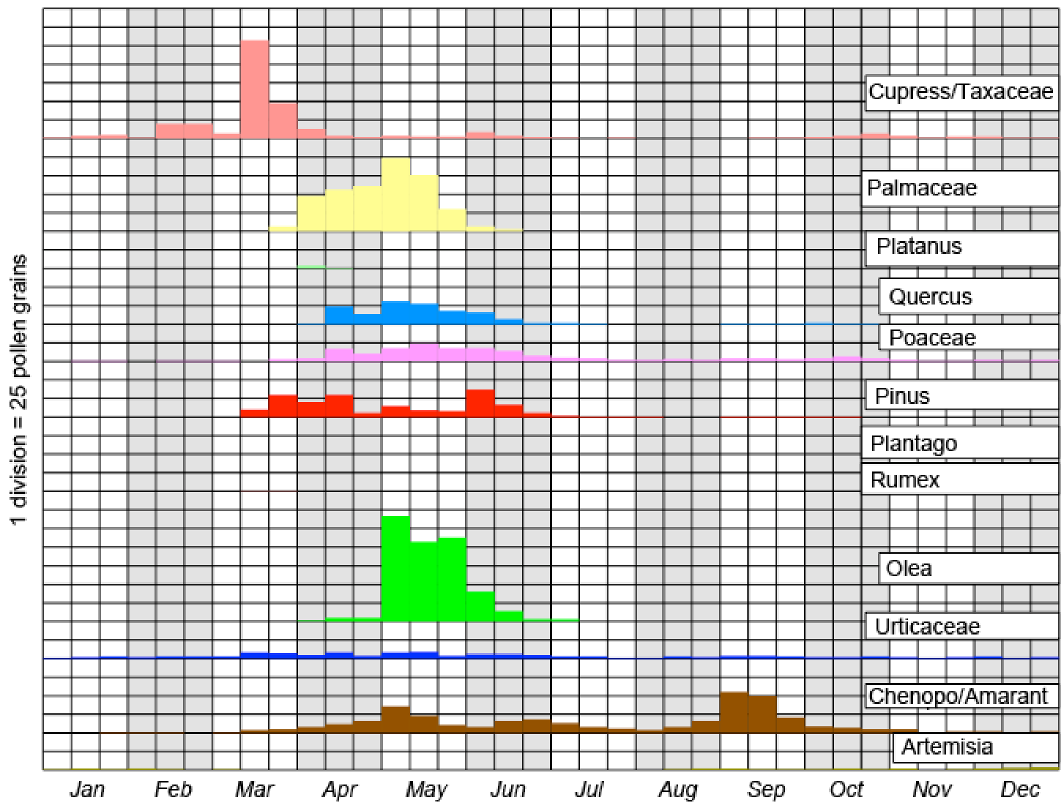

Figure 2. Pollen calendar for 2005.
The figure shows the pollen calendar for 2005 in the city of Elche. It can be observed how the pollens with the highest levels are Oleaceae, Palmaceae, and Cupressaceae.

Chenopodiaceae-Amaranthaceae: maximum levels between April and May, with a strong outbreak in September.

Oleaceae: sharp maxima between the month of May and the first half of June.

Palmaceae: maximum levels between April and May.

Poaceae: (Gramineae): low levels, with the maximum pollen observed from the second half of April to the second half of June.

Remaining pollens (Urticaceae, Plantaginaceae, Polygonaceae, and *Platanus. sp*) were present in very small quantities, generally from March until June and in September, although in quantities not exceeding 10 grains of pollen per cubic meter.

Regarding 1995, highlighted is the general delay in the onset of pollination (February to March), the increase in peaks for the most common taxa. The peaks for 1995 and 2005 were the following: Oleaceae, 132 vs. 624; Palmaceae, 144 vs. 288; and Cupressaceae, 96 vs. 318. The total levels were significantly different (<0.01) in 1995 vs. 2005 for Cupressaceae, 1,212 vs. 3,115; Poaceae, 707 vs. 1,945; and Urticaceae, 639 vs. 1290.

Climate data

Rainfall and average temperature values for Elche from 1995-2005 are shown in Figure 3. Total rainfall in 1995 (4,197 mL/m^3) was inferior to that of 2005 (7,586 mL/m^3), although this difference was not significant (p =0.056). For the preceding years (2001-2004), a significant increase was observed (p <0.01) in rainfall with respect to 1995.

The average temperature in 1995 (19.9ºC) was higher than that in 2005 (18.9ºC), but these differences were not significant.

Sensitization to pollens

From the initial sample of 276 patients, 76 (29.4%) where removed from the study as they were not diagnosed with a pollen allergy (a 13.1% diminution in comparison to the 1995 study). The final sample consisted of 195 patients (65 men and 130 women), whose age range varied from 14 to 76 years of age. Oculonasal symptoms were observed in 193 patients (99%), and asthma in 86 (44%).

Although the number of monosensitized patients was 41 (17.4%), which is a proportion similar to that in the previous study (16%), the type of

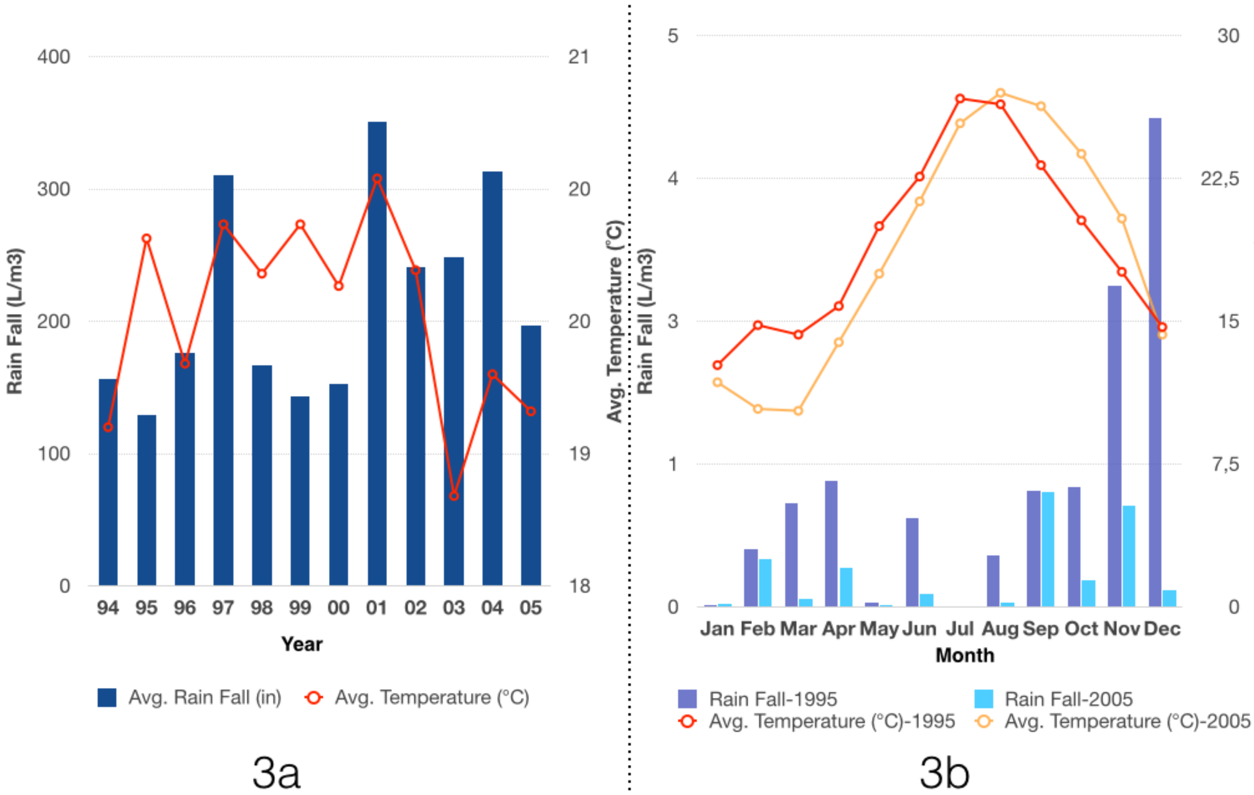

Figure 3. Climate data for the period 1995-2005.
Figure 3a shows rainfall and average temperatures in Elche for the period 1995-2005. Figure 3b focuses on the years 1995 and 2005 month by month.

Table 1. Representation of the percentage of association between the principal pollens observed.

Atmospheric presence (relative frequency)		
Pollen	1995	2005
Oleaceae.	16.66	19.40
Cheno-Amaranthaceae	18.02	16.66
Poaceae	5.41	5.9
Urticaceae	5.91	5.64
Palmaceae	15.82	17.03
Plantaginaceae	1.28	0.06
Sensitization by skin tests (%)		
Extract	1995	2005
Olea europaea	51.4	74.9
Salsola kali	53.7	71.8
Gramineae	47.7	44.1
Parietaria judaica	10.3	21.5
Phoenix dactylifera	5.6	22.3
Plantago lanceolata	17.8	38.5

The table represents the atmospheric presence of pollen and its correspondence to skin tests in 1995 and 2005.

monosensitization to pollen was different. In the present study, Oleaceae (53%) and *Salsola* (32%) represented the largest percentage of monosensitizations, followed by *Parietaria* (7%), Gramineae (5%), and *Artemisia* (5%); in the 1995 study, the most important source of monosensitizations were *Salsola* (75%), Gramineae (15%), and Oleaceae (10%).

The frequency of sensitizations to the primary pollens is shown in Table 1, which compares the results of atmospheric presence and skin test data from 1995 and 2005.

Discussion

Although weather naturally conditions plants flowering, human-mediated climate change has the potential to alter the phenology of plant populations and temporal patterns of pollen production. [11] In our area between 1995 and 2005, factors such as the type of soil and precipitation regimes limit the type of vegetation from growing very large as compared to plants of the same species at other locations. This characteristic makes intense pollinations pulses to

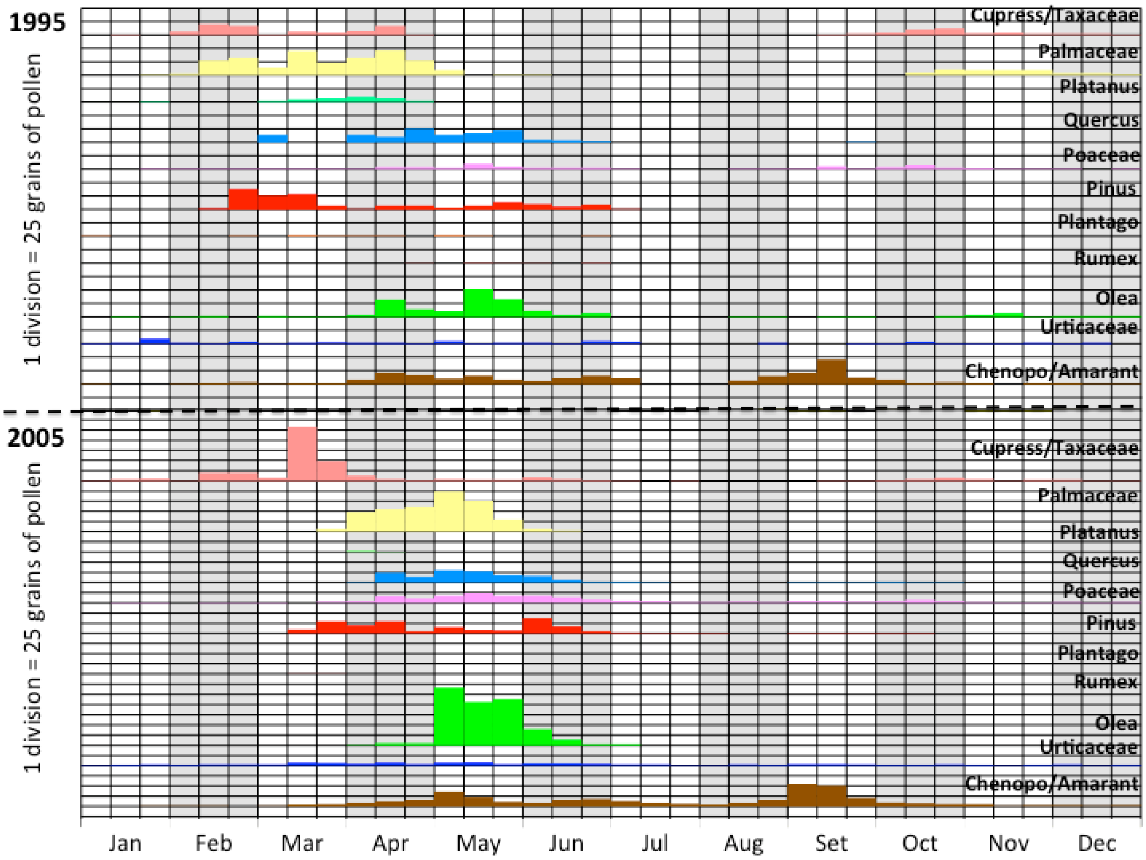

Figure 4. Pollen calendar 1995 vs 2005The figure shows the pollen calendar for 1995 vs 2005 in the city of Elche.

occur, taking full advantage of what little moisture rainfalls bring in a limited period of time.[12-14]

The actual concentrations of total pollens followed a distribution similar to the previous study, although a delay occurred in the onset of pollination. It is probable that the highest temperatures of 1995 induced an early spring (Figure 4) as observed in other nearby Spanish cities.[15-17]

The difference in the total quantity of pollens (22,854), significantly higher to that of 1995 (13,219), may be due to the prolonged drought the area underwent from 1993-1995. However, no differences were observed when comparing pollen calendars from these two study periods. The late spring and the significant increase in the pollen peaks of the main taxa in 2005, probably due to greater precipitation, are the most striking differences contrasting both study periods.

On the other hand, the number of patients sensitized to the main pollens (Oleaceae, *Salsola*, *Parietaria*, *Plantago*, and Arecaceae o Palmaceae) has increased substantially. Although the relative frequency of these pollens has not undergone significant variations, there has been an increase in pollen peaks, and this could be an explanation for the observed increased patient sensitization in the present study.

The percentage of monosensitized patients has not changed either, but the profile of these patients has. The increase in those monosensitized to olive pollen is noteworthy (10% in 1995 and 53% in 2005).

Pollution may be an important factor that increases allergenicity of pollens. The increase in average temperature and atmospheric CO_2 has been noted as a major factor in the development of vegetation.[11]

While the types of extract used in this study are similar to the 1995 study, several context-dependent reactions, in particular environmentally mediated, may have impacted sensitization in non-trivial ways and led to the differences observed.[18] Despite these potential confounding factors and possible technical limitations, we believe that the observed differences in sensitization reflect significant immunological patterns and are not driven by extracts technical improvement that may have occurred between 1995 and 2005 leading to higher sensitivity in skin tests, therefore increasing the number of positives cases. The main rationale behind this interpretation is the observation of novel pollen distribution variation but no sensitization intensity differences between the two studies.

The evolution in the amount of pollen and pollinosis are variables that need to be monitored over time and in different parts of Spain in order to corroborate the changes that appeared in this study, and they are necessary in order to address the changing needs of allergic patients in our country.

In conclusion, the pollen count showed a significant increase in the number of total *pollen grains*, probably due to increased rainfall or the influence of climate change caused by human activities, but with a very similar distribution of taxa. At the same time, an increase was observed in the number of sensitized patients, concomitant with a change in their sensitization patterns.

References

1. D'Amato G, Liccardi G. Pollen related allergy in the European Mediterranean area. Clin Exp Allergy. 1994; 24:210-9.
2. D'Amato G, Cecchi L, Bonini S, Nunes C, Annesi-Maesano I, Behrendt H, et al. Allergenic pollen and pollen allergy in Europe. Allergy. 2007;62:976-90.
3. Fernández Sánchez J, García Más F, Esteban A, Miralles A. Incidencia de granos de polen y polinosis en la ciudad de Elche, l995. Rev Esp Alergol Inmunol Clin.1998;13:88-91.
4. Wayne P, Foster S, Connolly J, Bazzaz F, Epstein P. Production of allergenic pollen by ragweed (*Ambrosia artemisiifolia* L.) is increased in CO_2-enriched atmospheres. Ann Allergy Asthma Immunol. 2002;88:279-82.
5. Wan S, Yuan T, Bowdish S, Wallace L, Russell SD, Luo Y. Response of an allergenic species, *Ambrosia psilostachya* (Asteraceae), to experimental warming and clipping: implications for public health. Am J Bot. 2002;89:1843-6.
6. Robert J Laumbach, Howard M Kipen. Respiratory health effects of air pollution: Update on biomass smoke and traffic pollution. J Allergy Clin Immunol. 2012;129:3-11.
7. D'Amato G, Cecchi L, D'Amato M, Liccardi G. Urban air pollution and climate change as environmental risk factors of respiratory allergy: an update. J Investig Allergol Clin Immunol. 2010;20:95-102.
8. Polenes [Open database Internet]. Madrid (SP): Sociedad Española de Alergología e Inmunología clínica. [updated 2010 Mar 05;cited 2010 Mar 16]. Available from: Available from: http://www.polenes.org/.
9. Skin tests used in type I allergy testing Position paper. Sub-Committee on Skin Tests of the European Academy of Allergology and Clinical Immunology. Allergy. 1989;10:1-59.
10. D'Amato Gennaro. Allergenic pollen and pollinosis in Europe. Oxford: Blackwell, 1991. p. 49–65.

11. Ziska L and Beggs P. Anthropogenic climate change and allergen exposure: The role of plant biology. J Allergy Clin Immunol. 2012;129:27-32.
12. Tiempo [Open database Internet]. Murcia: Alpred, S.L [updated 2010 Mar 01; cited 2010 Mar 16]. Available from: http://clima.meteored.com/clima-en-alicante+el+altet-083600.html
13. Fernández J, García F, Ferrer A y Soriano V. Incidencia de granos de polen. Elche 1993. Rev Esp Alergol Inmunol Clin. 1998;13:88-91.
14. Sanchís Moll, E. Guía de la naturaleza de la comunidad valenciana. Diario Información. Alicante: Prensa Alicantina, 1990.
15. Subiza Martín E, Subiza-Garrido-Lestache J, Jerez Luna M. Palinología. Tratado de Alergología e Inmunología Clínica. Tomo IV(II).1ª Ed. Madrid: SEAIC, 1986.
16. Subiza J, Feo Brito F, Pola J, Moral A, Fernández J, Jerez M. Polenes alergénicos y polinosis en 12 ciudades españolas. Rev Esp Alergol Inmunol Clin. 1998;13:45–58.
17. Hernández de Rojas M. D, Basomba, A, Subiza E. Allergenic pollen and Pollinosis in Spain. In D'Amato, Gennaro. Allergenic Pollen and Pollinosis in Europe. Oxford: Blackwell, 1991.
18. Curin M, Reininger R, Swoboda I, Focke M, Valenta R, Spitzauer S. Skin prick test extracts for dog allergy diagnosis show considerable variations regarding the content of major and minor dog allergens. Int Arch Allergy Immunol. 2011;154:258-63.