Correlation between Chenopodiacea/ Amaranthacea pollen counts and allergic symptoms in Salsola kali monosensitized patients

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Abstract. We performed a prospective observational study to establish a relationship between pollen counts of Chenopodiacea/Amaranthacea and clinical symptoms of rhinoconjunctivitis and asthma in a group of monosensitised patients.
Material and Methods. A total of 60 patients (19 with asthma) were included in the study. All patients collected daily symptom scores during the summer months of 1999, 2000 and 2001. The questionnaire included ocular, nasal and pulmonary symptoms. Pollen counts were expressed as pollen grains/m^3. Symptom scores and pollen counts were correlated using correlation coefficients and Log transformed variables.
Results: In the 3 seasons studied we identified a peak of pollen and clinical symptoms in the second half of August and first half of September . In 1999, there was a significant positive correlation between total symptoms and daily pollen grains/m^3 ($p<0.005$, $r = 0.347$). This correlation was not significant for the summers of 2000 and 2001. After further analysis, and by displacing one of both variables between 11 to 17 days, the correlation coefficients for total symptoms, improved for 1999 ($r = 0.744$; $p < 0.0001$) and became significant for 2000 ($r = 0.521$; $p < 0.0001$) and 2001 ($r = 0.635$; $p < 0.0001$).
Conclusion: We identified a significant time lag between pollen counts and symptom scores in *S. kali* monosensitized patients.

Introduction

The inhalation of *Salsola kali* pollen is an important cause of allergic respiratory symptoms in the West and Central states of the USA, in North Africa, and in Mediterranean and some Arabic countries [1-3]. In Zaragoza, Spain, sensitisation to *S. kali* occupies the second place in the prevalence of sensitisations observed in our outpatient clinic. It affects 42% of the patients with clinical sensitivity to pollens [4]. The highest pollen counts are detected at the end of August and beginning of September. Sal k 1, an important allergen in *S. kali* has been recently described. This allergen was characterized using serum samples from this area of Zaragoza [5].

In recent years, several studies have evaluated aeroallergen levels and pollen counts [6,7]. These studies have shown that there may be a lag between actual pollen counts and aeroallergen levels. Furthermore, a certain time lag between peak pollen counts and allergic respiratory symptoms has been suggested. Variable degrees of correlation between pollen counts and symptom scores have been obtained for grasses and birch pollen [8]. Several reasons have been argued for this

lack of correlation, including the different degrees of severity of symptoms perceived by the patients, the priming effect [9] and the presence of pauci-submicronic particles. These particles carry allergenic activity, which is not only present during the pollen season, but also outside of the pollination period [10]. Moreover, rainfall may also contribute to the release of allergens from pollen grains to trigger allergic asthma [11].

However, in the case of *S. kali*, the correlation between symptom scores and pollen counts could be hampered by the fact that in all aerobiological surveys, the pollen of several Chenopodiacea and Amaranthaceas species are grouped together, since they cannot be recognized individually. For example in Zaragoza, pollen grains of *Amaranthus albus*, *A. retroflexus*, *Atriplex halimus*, *A. portulacoides*, *Bassia scoparia*, *Chenopodium murale*, *C. album*, *Salicornia europaea*, *Salsola kali* and *S. vermiculata* are grouped together [12]. In Zaragoza, *B. scoparia* seems to be frequently present in urban areas, whereas *S. kali* and *S. vermiculata* are predominant in the surrounding rural areas [13]. Although variable degrees of cross-reactivity have been suggested between Chenopodiacea and Amaranthacea species [14,15], the allergenicity of many of the species present in Zaragoza has not been evaluated. A similar situation happens with grass pollen, where individual species cannot be accurately identified and are grouped together in aerobiological surveys, even though they may present different degrees of cross-reactivity.

Due to the importance of this pollen in this region of Spain, we decided to perform a prospective observational study in order to establish a relationship between pollen counts of Chenopodiacea/Amaranthacea and the intensity of clinical symptoms of rhinoconjuctivitis and asthma in a group of *S. kali* monosensitised patients.

Material and methods

Patient population

Patients were recruited from the Allergology Service of the University Clinical Hospital of Zaragoza.

Patients were selected consecutively, as they attended the Allergy Service. All were tested with standardized extracts of the following allergens: *Phleum pratense, Cynodon dactylon, Phragmites communis, Olea europaea, Plantago lanceolata, Salsola kali, Artemisia vulgaris, Parietaria judaica, Alternaria alternata, Cladosporium herbarum, Aspergillus fumigatus, Dermatophagoides pteronyssinus,* dog and cat epithelium. Skin prick tests were performed according to international recommendations [16]. The following inclusion criteria were used: age between 18 and 55 years, a clinical history suggestive of allergic rhinitis and/or asthma, monosensitization to *S. kali* (skin test equal to or larger than 6 mm in diameter, Laboratorios LETI, Spain), clinical symptoms during the pollination period of *S. kali* and capacity to fill the questionnaires and sign consent forms. The main exclusion criteria were sensitization to other pollens, excluding Chenopodiaceae, moulds or mites.

Symptom scores

All patients were asked to complete a symptom score questionnaire from mid July to mid September in 1999, 2000 and 2001. All lived in the urban area of Zaragoza. They were asked to enter daily ocular (eye watering, itching, conjunctival injection), nasal (itching, sneezing,

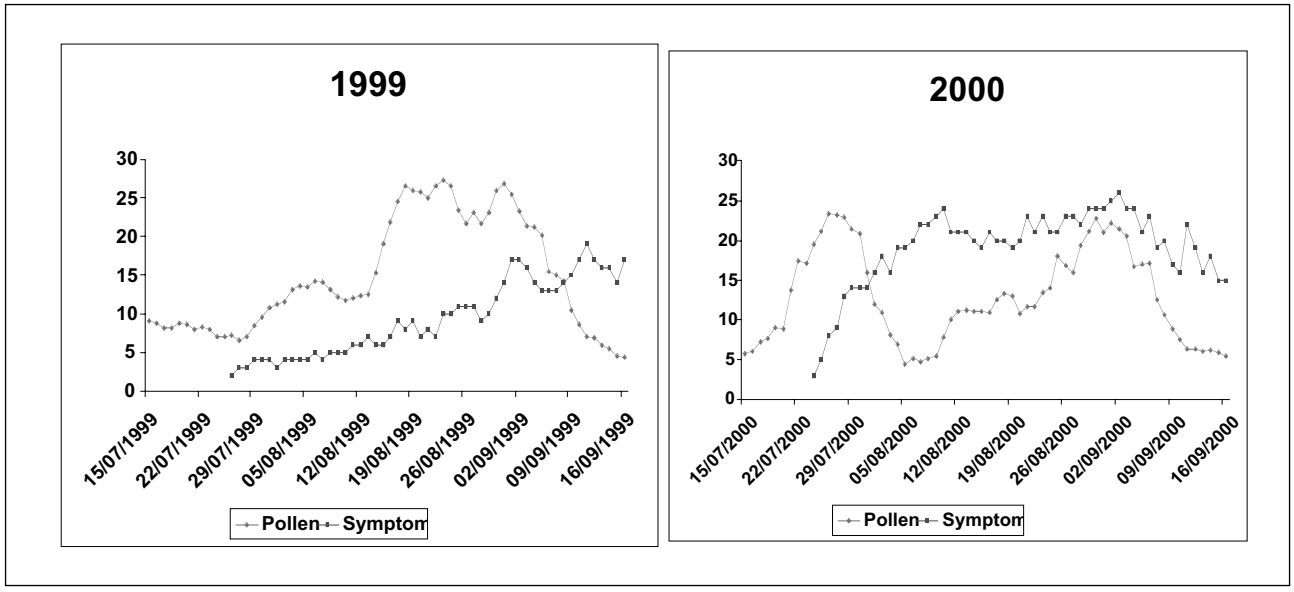

Figure 1. Pollen counts and symptom scores during the summers of 1999 and 2000. Pollen counts are expressed as Chenopodiacea/Amaranthacea pollen grains per cubic meter, and symptom scores as the mean total symptom scores.

obstruction, rhinorrhea) and bronchial symptoms (chest tightness, dyspnea, cough and wheezing) in the morning and by night. Symptom scores varied from 0 to 3 depending on the intensity; 0 meant no symptoms and 3 meant symptoms heavy enough to interfere with daily activities. The results are expressed as the mean daily total symptom scores of all the patients.

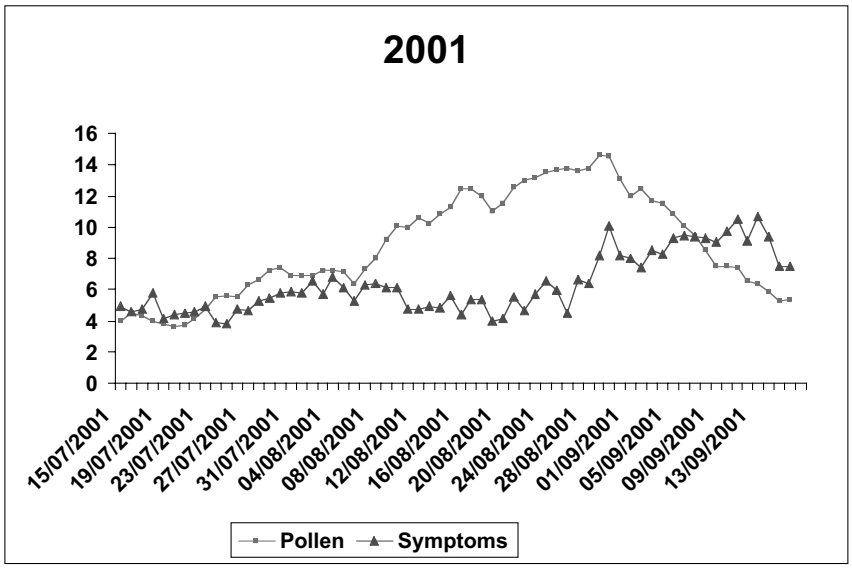

Figure 2. Pollen counts and symptom scores during the summer of 2001. Pollen counts are expressed as Chenopodiacea/Amaranthacea pollen grains per cubic meter, and symptom scores as the mean total symptom scores.

Pollen counts

Chenopodiacea/Amaranthacea pollen counts were provided by the counting station of Zaragoza, which supplies data to the Aerobiology committee of the Spanish Society of Allergology and Clinical Immunology (www.seaic.es). A Burkard collector, operating at 10 L/min and at 15 m of altitude, was used. The pollens were identified and counted by trained personnel.

Statistical analysis

The statistical analysis consisted in establishing correlation coefficients and statistical significance (Pearson) between symptom scores and pollen counts. Log transformed variables were also analysed using the SPSS v 10.0 statistical package.

Results

A total of 60 patients (43 females and 17 males) with clinical symptoms of rhinoconjuntivitis and monosensitised to *S. kali* pollen were entered in the study; 19 of these individuals also had asthma. Mean age was 32.9 years (18-51) and the mean duration time of the disease was 5.8 years (1-32). Twenty-one patients had a family history of atopy.

We detected an important peak of pollen and of allergic clinical symptoms in the second half of August and first half of September in the 3 seasons studied. In 1999, there was a significant positive correlation between total symptoms and daily pollen grains/m^3 ($p < 0.005$, $r = 0.347$). This significant correlation was not detected in the summers of the years 2000 and 2001. After analysing the data and plotting the graphs, it became evident that there was a time delay between the appearance of respiratory symptoms and of pollen in the air (Figures 1 and 2). After further analysis of both variables, symptom scores or pollen counts were displaced several days, until the best correlation for symptom scores and pollen counts was obtained (Table 1). Although the correlation coefficient was already significant for 1999, a 15 day lag between pollen counts and symptom scores was also identified, which improved the correlation coefficient for this year.

Table 1. Best correlation coefficients between total, nasal and bronchial symptoms and pollen counts obtained after corrections for time lags.

Year	**1999**	**2000**	**2001**
Lag	15 days	11 days	17 days
Nasal Symptoms	r = 0.448 p<0.0001	r = 0.274 p < 0.030	ND
Bronchial Symptoms	r=0.297 p<0.018	r=0.286 p<0.023	ND
Total Symptoms	r=0.744 p<0.0001	r=0.521 p<0.0001	r=0.635 p<0.0001

ND: Not done.

Discussion

We have identified a significant time lag between peak pollen counts and symptom scores analysing pollen counts and allergic symptoms in *S. kali* monosensitized patients. Pollen counts are generally considered a good indicator of the allergenic challenge confronting allergic individuals. This challenge depends on the type of pollen present in the atmosphere and on the airborne concentrations. In most cases, the clinical experience supports these assumptions. However, a coherent system for relating pollen counts and allergic symptoms is not currently available. This subject has been recently reviewed by Frenz [17]. Several reasons have been argued for a lack of correlation between pollen levels and symptom scores, since various parameters may influence a direct relationship between exposure to atmospheric pollen and symptoms. Some aspects have been reviewed, including the information contrasting human exposure patterns with rooftop pollen counts, and the data concerning dose-response relationships between atmospheric pollen counts and allergic symptoms. The main conclusions so far are that rooftop pollen counts do not completely reproduce human exposure to atmospheric pollen counts, since there may be differences in the concentration and types of pollen encountered by humans at street level and in samples obtained on rooftops. Another conclusion was that allergic symptoms are generally positively correlated with atmospheric pollen counts, since quantitative dose-response models have been obtained. However, complex, nonlinear relationships exist, that seem to reflect both the priming effect and late-phase reactions. A significant correlation between air pollution and symptom scores has also been shown [18], and it has been suggested that allergens, carried on pollen grains, or on plant-derived paucimicronic components, may interact with air pollution. Airway mucosal damage and impaired mucociliary clearance induced by air pollution may facilitate the access of inhaled allergens to the cells of the immune system, thus influencing the overall symptom scores.

Our results suggest that after a pollination period, allergens may be released from the pollen grain and re-suspended. Ricca et al. [19] showed a significant inflammatory reaction throughout the pollen season, even during the days with low pollen counts. A constant exposure to allergens, even when they do not produce symptoms, seems to promote and maintain the inflammatory response. This inflammatory response is associated with the expression of ICAM-1 in the epithelial cells or in the inflammatory infiltrate in the mucosa. Furthermore, towards the end of the season when pollen counts dropped to initial values, patients remained symptomatic. Subiza et al. have also observed a lag of 7 to 14 days since the appearance of the first pollen grains in the air of Madrid until the first symptoms were registered in daily symptom cards [20]. This time lag was even longer for the appearance of asthma symptoms.

It has been suggested that different varieties of the same plant species, i.e., *Olea europaea*, may not have the same allergenicity [21]. This fact may have important consequences when interpreting pollens counts, since pollen grains from the same plant species may not all carry the same allergen load. Different *Chenopodiacea/Amaranthacea* species do pollinate at the same time as *S. kali* in Zaragoza. The allergenicity, or lack thereof, of some of these species remains to be established. Therefore, it would not be surprising if the early pollinating plants would not be so allergenic and less capable of inducing symptoms in *S. kali* mono-sensitized patients.

Based on the results obtained in our study we conclude that there is a lag between total *Chenopodiacea/Amaranthacea* pollen counts and clinical symptoms in *S. kali* sensitized individuals. We have not been able to identify the causes of this apparent delay. We postulate that several factors may have influenced the results, especially the fact that *Chenopodiacea/Amaranthacea* pollen grains are grouped together and that pollen counts were collected at the roof top level. However, the slides collected did show the presence of *S. kali*-like pollen in the air, which is suggestive of exposure to pollen and allergens of Chenopodiaceae. *S. kali* pollen counts, which are responsible for symptoms, have not been established, but it seems that several days of exposure may be needed to induce symptoms. Pollen counts at street levels in urban areas, and a thorough allergological analysis of the *Chenopodiacea/Amaranthacea* species present in Zaragoza may be needed to add more information to this conflicting issue. Chenopodiacea and Amaranthacea pollen counts may not reflect the exact pollen season when *S. kali* produces clinical symptoms. More accurate methods, such as immunochemical techniques, may be needed to correlate *S. kali* aeroallergen levels with clinical symptoms.

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