Pollens aero allergens and the climate in mediterranean region and allergen sensitivity in allergic rhinoconjunctivitis and allergic asthma patients

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Background: We evaluated the profiles of allergic rhinoconjunctivitis and asthma patients annually in Antalya, a Mediterranean coastal city in Turkey.

Material/Methods: We evaluated patients' allergic clinical status, and recorded the climate and pollens in the city center air, investigating any correlation between pollination, climatic conditions and allergic disorders. The meteorological conditions and the pollen count/cm² during every month of the year and the concordance of this with the patient's clinical status were evaluated.

Results: SPT positivity for plantago lanceolata, aspergillus fumigatus and d. pteronyssinus was significant in patients younger than 40 years old. Pollination levels are consistent from March 2010 to February 2011. In Antalya, high levels occur mostly from April to June, thus we performed skin prick tests mostly in May/June (~30%). During these months meteorological conditions of the city were windy with low humidity, without rain, and lukewarm temperatures, all of which contribute to high-risk conditions for seasonal allergies.

Conclusions: The major allergen between April and June was derived from Gramineae; between February and March was Cupressus spp; and between March and June was Pinus spp. These results suggest that the pollination is correlated with allergic conditions and thus SPT might be best performed according to the pollen count.

Key words: aero allergens, climate, allergic rhinoconjunctivitis, allergic asthma

Mediterranean coast

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Background

Allergic rhinoconjunctivitis is a common health problem, with 2 forms: seasonal and perennial. The prevalence and etiology of allergic rhinoconjunctivitis varies from region to region and affects approximately 10%-20% of the population. Several studies have investigated the association between pollen exposure and asthma emergency admissions, but only 2 have investigated the effect of airborne allergens on consultations for rhinitis [1–3].

The prevalence of asthma, allergic rhinitis, and allergic eye disease is 8.2%, 10.8% and 7.5%, respectively, in Antalya, a city on the south coast of Turkey [4]. Asthma affects individuals of all ages and there is evidence that its prevalence is increasing [4–6]. Asthma is recognized as a complex condition with a wide range of severity, natural history, comorbidities, and response to treatment. It has been defined as “a common chronic disorder of the airways,” characterized by variable and recurring symptoms, airflow obstruction, bronchial hyper-responsiveness, and underlying inflammation [7]. There are various ways to classify asthma, although no universally accepted classification of subsets differing in severity exists. Symptoms in the most severe form of asthma, called “severe persistent allergic asthma,” are precipitated by allergen exposure [7–9].

Allergic disorders and rhinitis are increasing in prevalence, particularly in industrialized Western societies [9–11]. Allergic diseases are most likely caused by complex interactions between largely unknown genetic and environmental factors. A positive family history of atopic disease is often present; concordance between monozygotic twins is consistent with an important role for genetic factors [12]. Epidemiologic studies have also suggested a relationship between allergic rhinitis and diet, hygiene, and life-style, consistent with an effect of environmental factors on the development of allergic rhinitis [13]. Allergic rhinitis has a negative impact on socialization, well-being, quality of life, and employment [14,15]; all of which confirm that allergic rhinitis has a substantial socio-economic impact [10–20].

In the Antalya region, allergic disorders can be stimulated by allergens from local vegetation, including many types of herbs, plants and trees. The warm, humid climate also provides an ideal environment for mites and cockroaches, and recently the volume of industrial activity in the surrounding region has increased considerably. Because of its geographic localization, Turkey is a Mediterranean country with rich plant diversity; recent taxonomic studies reported more than 10,000 specimens. According to previous studies on the plants of Turkey and the urban plant flora of Antalya, there are 1069 species reported in the city center and 2473 in the surrounding area [21,22].

We used a skin prick test (SPT) and allergen-specific and total IgE levels to characterize 866 patients evaluated in the Clinics of Internal Medicine, Allergy and Clinical Immunology Division of the Antalya Training and Research Hospital. We also recorded the climate and pollens in the city center air to evaluate any correlation between pollination, climatic conditions, and clinical status of the allergic patients.

Material and Methods

Patients

The study was approved by the local ethics committee, and written consent was obtained from all patients and healthy volunteers. The study was conducted in Antalya between March, 2010 and February, 2011. Our study enrolled 866 of 2862 patients who had allergic rhinoconjunctivitis and asthma, and were found to have high total IgE levels, at the Allergy and Clinical Immunology Division of the Antalya Training and Research Hospital. SPT was performed on all of these 866 patients, and the positivity of the SPT and its accordance with the season was evaluated. A questionnaire was used to obtain data to determine various socio-demographic characteristics including, age, sex, place of residence, allergens that exacerbate disease, and smoking status.

Allergic rhinoconjunctivitis and asthma were diagnosed by history, physical examination, high eosinophil count, total and allergen-specific IgE levels, respiratory function tests, and skin prick test results. A strong history of coughing spells, nasal drainage, nasal obstruction, itching sensation in the nose, tearing and itching in the eye, along with physical examination findings of pale and hypertrophic conchae, pale nasal mucosa, and the presence of nasal serous secretions, suggested allergic rhinitis.

Cases with symptoms suggesting allergic rhinitis, which also had eosinophilia and prick test positivity, were diagnosed as having allergic rhinitis. In other subjects with allergic rhinitis symptoms together with low prick test positivity, allergen-specific IgE levels were used to confirm the diagnosis.

Laboratory methods

Total and specific IgE levels were determined by a fluoroenzyme immunoassay (ImmunoCAP-FEIA) method using an ImmunoCAP (Phar-macia, Uppsala, Sweden) kit. Values above 100 kU/L and 0.35 kU/L (total and specific IgE levels) were considered high.

Skin Prick Tests (SPT)

In all patients, skin prick tests on the forearm were performed using standardized latex extract containing high-ammonia
Table 1. Demographics for the patient group (n=866).

| Age     | Number of patients | Percentage% |
|---------|--------------------|-------------|
| Male    | 294                | 33.9        |
| Female  | 572                | 66.1        |

| Age     | Number of patients | Percentage% |
|---------|--------------------|-------------|
| 10–19   | 179                | 20.7        |
| 20–29   | 192                | 22.2        |
| 30–39   | 203                | 23.4        |
| 40–49   | 155                | 17.9        |
| 50–59   | 83                 | 9.6         |
| 60+     | 54                 | 6.2         |

Clinical visit numbers per month

| Month   | Number | Percentage% |
|---------|--------|-------------|
| January | 59     | 6.8         |
| February| 92     | 10.6        |
| March   | 86     | 9.9         |
| April   | 104    | 12.0        |
| May     | 152    | 17.6        |
| June    | 127    | 14.7        |
| July    | 55     | 6.4         |
| August  | 40     | 4.6         |
| September| 48     | 5.5         |
| October | 24     | 2.8         |
| November| 40     | 4.6         |
| December| 39     | 4.5         |

Exacerbation of rhinitis and asthma symptoms was most commonly attributed to air pollution. SPT positivity for corylusavellana was significant in the age group of >40 years old. SPT positivity for plantagolanceolata, aspergillus fumigatus and D. pteronyssinus was significant in patients younger than 40 years old (Table 3), but there was no difference in SPT positivity between the males and females. As shown in Table 4, the sensitivity for the grass, barley, weed, and tree allergen mixtures of SPT was significantly increased in May and June. During the month of May, air pollination of gramineae was also increased (Table 5).

Most cases reported that their rhinitis symptoms were due to pollen and/or house dust mites (the second most common irritant). Pollen count per cm² was recorded as 1447.9 over the whole year, with a maximum in May and minimum in January. The monthly pollen count for the city during a 1-year period is

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Table 2. Skin prick test results for patients (n=866) and % positivity to different allergens.

| Test                      | x ±SD (mm) | Minimum maximum size (mm) | Number of patients | Percentage of patients |
|---------------------------|------------|---------------------------|--------------------|------------------------|
| Positive control          | 11.15±3.79 | 1–24                      | 863                | 99.6                   |
| Negative control          | 0.17±1.03  | 2–10                      | 23                 | 2.6                    |
| Grass mix                 | 5.86±4.03  | 1–30                      | 703                | 81.2                   |
| Holcus lanatus            | 4.14±4.08  | 3–23                      | 512                | 59.1                   |
| Dactylis glomerata        | 4.75±4.40  | 3–26                      | 594                | 68.6                   |
| Lolium perenne            | 4.56±4.29  | 1–28                      | 568                | 65.6                   |
| Phleum pratense           | 3.46±3.76  | 3–21                      | 452                | 52.2                   |
| Poa pratensis             | 3.54±3.92  | 2–24                      | 459                | 53.0                   |
| Festuca pratensis         | 3.15±3.74  | 2–19                      | 416                | 48.0                   |
| Barley mix                | 0.08±0.20  | 4–30                      | 516                | 58.6                   |
| Hordeum vulgare           | 2.78±3.65  | 3–20                      | 366                | 42.3                   |
| Triticum sativum          | 2.61±3.54  | 2–20                      | 351                | 40.5                   |
| Secale cereale            | 2.32±3.63  | 2–22                      | 316                | 36.5                   |
| Avenasativa               | 2.32±3.35  | 2–18                      | 319                | 36.8                   |
| Weed mix                  | 3.35±3.39  | 1–21                      | 471                | 54.4                   |
| Artemisia vulgaris        | 3.26±3.21  | 3–14                      | 477                | 55.1                   |
| Urtica dioica             | 2.45±2.99  | 2–12                      | 372                | 42.9                   |
| Plantago lanceolata       | 2.65±3.15  | 3–18                      | 396                | 47.7                   |
| Taraxacum officinale       | 2.46±3.33  | 3–20                      | 353                | 40.8                   |
| Tree mix                  | 3.22±3.46  | 3–21                      | 433                | 50.0                   |
| Alnus glutinosa           | 2.40±3.19  | 3–18                      | 337                | 38.9                   |
| Corylus avellana          | 2.42±3.50  | 3–44                      | 326                | 37.6                   |
| Salix caprea              | 2.69±3.08  | 2–11                      | 397                | 45.8                   |
| Betula verrucosa          | 2.12±2.99  | 3–10                      | 307                | 35.4                   |
| Pinus silvestris          | 1.45±2.68  | 3–10                      | 207                | 23.9                   |
| Quercus robur             | 2.58±3.03  | 3–10                      | 386                | 44.6                   |
| Olea europaea             | 0.17±0.93  | 2–10                      | 21                 | 2.6                    |
| Olea eurpeae              | 3.57±4.38  | 3–18                      | 491                | 56.7                   |
| Epithelial allergens      |            |                           |                    |                        |
| Dog                       | 3.30±3.14  | 2–10                      | 486                | 56.1                   |
| Cat                       | 2.91±3.26  | 3–15                      | 416                | 47.8                   |
| Fungal allergens          |            |                           |                    |                        |
| Alternaria                | 3.38±3.18  | 2–18                      | 496                | 57.3                   |
| Aspergillus fumigatus     | 3.36±3.17  | 3–19                      | 493                | 56.9                   |
| Mite mix                  |            |                           |                    |                        |
| Blatella germanica        | 2.73±3.32  | 3–35                      | 457                | 52.8                   |
shown in Table 5. Pollens of Graminea plants known to be very allergic were frequently detected between May and November. The other pollen ratios are shown in Figure 1A.

The densities of the allergenic pollens were determined throughout the year. Gramineae pollen, found in the atmosphere during May to July, generates 40% to 55% of the total pollen (Figure 1); Chenopodiaceae/Amaranthaceae pollens found during June to October generate 2% to 17% (Figure 1A); Pinaceae pollen found during March to December generate 2% to 42%; and Cupressaceae pollens found especially in February generate ~90% of the total pollen in the atmosphere, with periodic effects continuing from February to May (Figure 1B, 1C).

Temperature changes in Antalya during the year are shown in Figure 2. The average temperature was highest in July and August. The rainfall rate was at its minimum level between May and August (Figure 3), while wind speed was highest in the same period from May to June (Figure 4). Comparing these data and the patient numbers in the allergy and clinical immunology clinics, there was a significant concordance as shown in Table 1 (17.6% in May and 14.7% in June). Additionally, as shown in Figure 5, the increase of humidity in January and October was significant.

Discussion

According to the so-called hygiene hypothesis, the increased rate of allergic diseases in city centers may be attributed to many factors, including improved hygienic conditions, a decreased infection rate in infancy and childhood, a sedentary lifestyle, and increased time spent indoors. These changes attenuate activation of the innate immune system and maturation of the acquired immune system. The immune system is thought to show Th-2 dominance during intrauterine life and infancy, and relies on challenge from infectious agents during development to drive Th-1 responses. The failure of this change leads to emergence of allergic diseases; the latter are

Table 3. Age distribution (n=866) and mean SPT positivity.

| AGE   | Corylusavellana X±SD (mm) | Aspergillus fumigatus X±SD (mm) | Dpteronyssinus X±SD (mm) | Plantagolanceolata X±SD (mm) |
|-------|---------------------------|---------------------------------|--------------------------|-------------------------------|
| <40   | 2.21±3.14                 | 3.59±3.12                       | 4.12±3.78                | 3.00±3.49                     |
| 40+   | 2.82±4.09                 | 2.93±3.23                       | 3.42±3.47                | 2.19±2.90                     |
|       | Independent-samples t-test| p=0.02                          | p=0.004                  | p=0.008                       | p=0.001                       |

Table 4. The most commonly detected months of the allergens.

| Allergens   | Most common on ... | %   |
|-------------|---------------------|-----|
| Grass mix   | May (n: 115), June (n: 97) | 30.2 |
| Barley mix  | May (n: 94), June (n: 89) | 35.5 |
| Weed mix    | May (n: 71), June (n: 71) | 30.1 |
| Tree mix    | May (n: 77), June (n: 77) | 35.6 |

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Table 5. Monthly pollination ratios.

|            | March | April | May | June | July | August | September | October | November | December | January | February | Total |
|------------|-------|-------|-----|------|------|--------|-----------|---------|----------|----------|---------|----------|-------|
| Pinaceae   | 62.1  | 125.9 | 56.2| 24.5 | 3.1  | 0.0    | 1.6       | 1.3     | 0.6      | 0.4      | 0.0     | 275.7    | 19.0  |
| Cupressaceae| 84.9  | 8.2   | 2.7 | 1.1  | 0.0  | 0.0    | 0.0       | 0.0     | 0.0      | 0.0      | 0.0     | 65.3     | 162.2 |
| Gramineae  | 0.6   | 4.0   | 202.9| 78.6 | 51.1 | 22.9   | 13.4      | 1.8     | 0.4      | 0.0      | 0.0     | 0.0      | 375.7 |
| Ericaceae  | 0.0   | 0.0   | 0.2 | 0.0  | 0.0  | 0.0    | 0.0       | 0.0     | 0.0      | 0.0      | 0.0     | 0.0      | 0.7   |
| Chenopodiaceae| 0.0  | 0.0   | 0.0 | 7.4  | 17.8 | 3.2    | 0.8       | 3.0     | 0.0      | 0.0      | 0.0     | 0.0      | 32.1  |
| Amaranthaceae| 104.4| 155.2 | 110.1| 87.8 | 41.0 | 19.6   | 29.5      | 31.6    | 5.2      | 5.9      | 3.3     | 8.0      | 601.5 |
| Unidentified   | 252.0| 293.3 | 372.1| 199.3| 113.0| 45.6   | 45.3      | 37.7    | 6.7      | 6.3       | 3.3     | 73.3     | 1447.9 |
| Total        | 17.4  | 20.3  | 25.8| 13.8 | 7.8  | 3.2    | 3.1       | 2.6     | 0.5      | 0.4       | 0.2     | 5.1      | 100.0 |
more prevalent in industrialized countries with higher socio-economic status, where infant immunization occurs and mycobacterial infections do not occur [5–9].

The diagnosis of allergic rhinitis is generally made before the age of 40. In our previous study, we reported that allergic rhinitis symptoms began during childhood, but firm diagnosis was often delayed until the second or third decades of life, with new diagnoses decreasing after the fourth decade [4]. The decrease in positive SPT rates with age, seen above, might reflect the greater amount of time spent indoors in older age groups, and a contributing effect on pollen exposure. Pollination schedules are consistent from year to year, and in Antalya occur mostly from April to June. Thus skin prick tests were performed mostly in May/June (~30%). During these months, the meteorological conditions of the city were windy with low humidity and without rain, and a warm climate, all of which makes for a climate perfect for allergies. Graminae was the major allergen between April and June; Cupressus spp between February and March; and Pinus spp between March and June. These results suggest that the pollination was correlated with...
in March (beginning of spring) and pollens of the Graminea family mostly in late spring between April and October. A previous study reported from the south Mediterranean coast of Spain suggested the family of Cupressaceae pollens were the main allergens for patients. Other studies suggested that high humidity and low wind speed caused exacerbation of allergic reactions and asthma symptoms [24,25]. In our study, in late spring (especially in May) patients’ symptoms of allergic rhinitis and asthma were increased according to periods of low rain fall and high wind speed. 

Cockroaches live at a temperature of 20–25°C, with a relative humidity of 60–70%, especially in kitchens and bathrooms. In Turkey, of 20 different species, Blattella germanica is most commonly found in Antalya. The reported cockroach sensitivity rate in adult asthma patients in Turkey varies between 4.3% and 36% [20], and was ~53% in this study. Our higher observed sensitivity rates might be due to the environment of Antalya, a city on the south coast, with a hot, humid Mediterranean climate. Eradication of cockroaches depends upon fastidious attention to hygiene and regular use of insecticides.

Our subjects are acutely aware of their clinical condition. As in all chronic diseases, knowing what is harmful and what is good for their health helps them cope with their disease more easily. Pollen allergies differ according to the pollens present in the atmosphere, which itself is a function of the flora of the region and the duration of the pollen season. Pollen allergies generally cause seasonal allergic rhinitis [3–7]. In our previous study [27,28], we found that the most frequent allergens were grass/cereal mixtures and dust mites. In this study, when we evaluated prick test results according to age groups, the SPT positivity decreased with increased age groups for grass and cereals. However, only the Plantagolanceolata and Corylusavellana sensitivity was statistically different by age.

Though allergic rhinitis is a chronic inflammatory disease, many patients have no regular treatment or have no treatment at all. Many drugs are already developed or under development for treatment of allergic diseases. Some of these drugs include inhibitors of pro-inflammatory cytokines, anti-IgE antibodies, drugs blocking adhesion molecules, and immune-biological agents including, eg, chemokine inhibitors [29–31]. Many studies have suggested markers that will enable us to monitor clinical improvement. Our earlier studies provided a novel perspective on severe persistent allergic asthma, using as markers serum sTRAIL, NO, MDA, H2O2, high sensitive CRP, total antioxidant capacity, and ceruloplasmin oxidase activity measurements [32–35]. Avoidance of the inciting allergen is still the primary therapy for all allergic patients, and is a very effective treatment option, particularly for allergies to food, drugs and animal dander. However, there is great difficulty in avoiding mites and pollens that are present in the atmosphere.
in large amounts. For mites, measures to decrease the aller-
gen "load" in the environment include frequent cleaning of pil-
lows, coverlets, mattresses and toys. Carpets and rugs should
be replaced with hard flooring, and chemical eradication of
the mites should be considered.

Conclusions

In conclusion, this study provides important information linking a high prevalence of allergic diseases to environmental condi-
tions. In our region of Turkey, Antalya, the prevalence of asth-
ma is quite high because of the high temperature, moisture
and dense pollination. Allergic rhinoconjunctivitis is the most
common allergic disorder among occupants of “shanty-type”
housing, and housewives suffer most frequently [3,4]. Allergens
are known to exhibit regional variation in expression, which
helps explain why allergy profiles and skin prick tests should
be designed with reference to individual locales. From the ob-
servations in our clinic, grass, cereal mixtures, and mites were
responsible for most cases of allergic rhinoconjunctivitis seen,
with other important allergens linked to the flora and climate
of the region, including olives and cockroaches. The high asth-
ma prevalence in housewives and in people living in shanties
may be due to exposure to house dust mites.

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Competing interests

The authors declare that they have no competing interests.

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