



Original Article

Role of Pollen Allergy in Taiwanese Patients With Allergic Rhinitis

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Background/Purpose: Pollen allergy is believed to be less common in East Asia, Latin America, and tropical areas. The purpose of this study was to understand the role of pollen allergy in Taiwan.

Methods: Patients with clinically diagnosed allergic rhinitis were enrolled. All subjects received a 30-item skin test panel that included perennial allergens (house dust mix, *Dermatophagoides pteronyssinus*, *Dermatophagoides farinae*, dog epithelium, cat hairs, cockroach mix, and *Candida albicans*) and pollen allergens (acacia, pine mix, eucalyptus, beefwood, juniper mix, willow, mulberry mix, pepper tree, cedar, Johnson grass, Bermuda grass, ragweed mix, Timothy grass, spiny pigweed, cocklebur, sage mix, sheep sorrel, dog fennel, pigweed mix, English plantain, castor bean, alfalfa, and dandelion).

Results: A total of 419 patients were recruited. A total of 313 (74.7%) had a positive skin test. A total of 288 patients (68.7%) were sensitive to perennial allergens, and 118 patients (28.2%) were sensitive to pollen allergens. However, 93 pollen-sensitive patients were also sensitive to perennial allergens, and only 25 were sensitive to pollen allergens alone. The most common allergens were *D. pteronyssinus*, *D. farinae*, house dust mix, and cockroach, but the most common pollen allergens were spiny pigweed, Johnson grass, and sheep sorrel. All nasal symptoms tended to be more severe in patients who were sensitive to perennial allergens than in those who were sensitive to pollen allergens alone.

Conclusion: Most patients with allergic rhinitis in Taiwan are sensitive to perennial allergens, and pollens are a less common allergen.

Key Words: allergic rhinitis, mite, pollen allergen, skin test, Taiwan

Pollen was one of the first allergens to be identified. Pollen allergy is very common in many parts of the world but it is believed to be less common in East Asia, Latin America, and tropical areas.¹

The sensitive pollens are different geographically because their nature and number vary with location, temperature, and climate.² Although there are many studies in the literature related to pollen

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Received: October 11, 2009

Revised: November 15, 2009

Accepted: December 25, 2009

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allergy in western countries, few studies have been conducted in tropical or subtropical areas.³

Taiwan is an island on the western edge of the Pacific Ocean and lies off the south-eastern coast of mainland Asia. It is located in a subtropical climate zone. Two-thirds of Taiwan is covered by forested mountains and the remaining area consists of hilly country, plateaus, highlands, coastal plains, and basins. The wide range of geographic areas in Taiwan has given rise to a wide diversity of fauna and flora, which includes over 4,000 plants species. The weather in Taiwan is warm all year round, with a mean monthly temperature of 15–20°C in the winter and around 28°C in the summer. There are no large fluctuations in weather conditions. Most plants grow all year round.⁴

The prevalence of allergic rhinitis (AR) in Taiwan is 24.6% in school children.⁵ The estimated prevalence of AR in adults is around 20% but without population-based surveillance. Although there are plenty of plants, the major aeroallergen in Taiwan is the mite.^{6–8} Therefore, the role of pollen allergy has been largely ignored by doctors and patients. In this study, we tried to evaluate the prevalence and the role of pollen allergy in AR patients in Taiwan.

Materials and Methods

Patients who had typical AR symptoms for > 2 years were enrolled from the outpatient clinic of the Department of Otolaryngology, Taichung Veterans General Hospital, between June 2005 and May 2007. The typical symptoms included nasal obstruction, sneezing, rhinorrhea, itchy eyes and nose. Patients aged < 12 years old or who were pregnant, who had a history of anaphylaxis or unstable asthma, or who had taken oral antihistamines or steroids within a week before skin testing were excluded. This study was approved by the Institutional Review Board of Taichung Veterans General Hospital.

All eligible patients received a prick skin test with seven perennial allergens and 23 pollen allergens. The selection of perennial allergens was based

on our previous skin test results from 314 AR patients.⁹ The allergen extracts were produced by Greer Lab (Lenoir, NC, USA). The perennial allergens included the most common allergens in Taiwan: house dust mix, *Dermatophagoides pteronyssinus* (Der p), *Dermatophagoides farinae* (Der f), dog epithelium, cat hairs, cockroach mix (American cockroach, German cockroach), and *Candida albicans*. The pollen allergens included nine kinds of tree pollens (acacia, pine mix, eucalyptus, beefwood, juniper mix, willow, mulberry mix, pepper tree, and cedar); 11 kinds of grass or weed pollens (Johnson grass, Bermuda grass, ragweed mix, Timothy grass, spiny pigweed, cocklebur, sage mix, sheep sorrel, dog fennel, pigweed mix, and English plantain); and three other plant pollens (castor bean, alfalfa, and dandelion).

A questionnaire was used to assess the allergy history and severity of symptoms. The questionnaire included items to determine whether symptoms were intermittent (< 4 days/week or < 4 weeks/year) or persistent ($\geq$ 4 days/week and $\geq$ 4 weeks/year), whether they occurred indoors or outdoors, and whether or not symptoms interfered with sleep or daily activities. A visual analog scale was used to grade the severity of nasal obstruction, sneezing, rhinorrhea, and itchy eyes and nose within the previous 2 weeks. The severity was graded as 0 for no symptoms at all and as 10 for most severe symptoms.

All patients were grouped according to the results of skin testing. Group 1 comprised patients who were only sensitive to pollen allergens, and group 2 comprised those only sensitive to perennial allergens. Patients in group 3 were sensitive to pollen and perennial allergens, and those in group 4 were patients whose skin test was negative. Groups were compared using the χ^2 test based on the variables assessed in the questionnaire, namely, intermittent or persistent symptoms, indoor or outdoor symptoms, and whether or not symptoms interfered with sleep or daily activities. The severity of symptoms among the four groups was compared using the Kruskal–Wallis test. The subgroups were compared using the Mann–Whitney *U* test. All statistical tests were two-sided and assessed at

Table 1. Correlation of symptom variables and skin test results

	Skin test*				P
	Pollens (n = 25)	Perennial allergens (n = 194)	Both (n = 93)	Negative (n = 107)	
Symptom duration					0.476
Intermittent	3	49	23	23	
Persistent	22	145	70	84	
Location					0.567
Indoors	6	61	32	30	
Outdoors	1	7	4	9	
Both	18	126	57	68	
Impact on sleep					0.883
None	2	26	14	17	
Mild	11	64	33	33	
Moderate	9	59	24	33	
Severe	3	45	22	24	
Impact on daily activities					0.790
None	4	23	11	8	
Mild	8	72	35	38	
Moderate	10	54	25	32	
Severe	3	45	22	29	

*Results of skin test were divided into four groups: (1) sensitive to pollen allergens alone; (2) sensitive to perennial allergens alone; (3) sensitive to pollen and perennial allergens; and (4) negative.

the 0.05 significance level. Analyses were performed using SPSS version 17 (SPSS Inc., Chicago, IL, USA).

Results

A total of 419 patients were recruited for this study. There were 244 male and 175 female patients with a mean age of 29.8 ± 16.8 years old. The skin test was positive in 313 (74.7%) patients. Two hundred and eighty-eight (68.7%) patients were sensitive to perennial allergens and 118 (28.2%) were sensitive to pollen allergens (Table 1). Among those sensitive to pollens, 93 were also sensitive to perennial allergens and 25 were only sensitive to pollen allergens. A total of 50 of the 118 pollen-sensitive patients were sensitive to one kind of pollen, and the other 68 were sensitive to more than one kind. The characteristics of pollen-sensitive patients are listed in Table 2. The most common allergens were Der f (sensitivity

rate = 58.7%), Der p (51.1%), house dust mix (39.1%), and cockroach mix (36%), but the most common pollen allergens were spiny pigweed (11.7%), Johnson grass (10%), and sheep sorrel (9.1%) (Table 3).

According to the results of the questionnaire, nasal symptoms were intermittent in 98 (23.4%) patients and persistent in 321 (76.6%). A total of 306 patients (73%) reported their symptoms as occurring at any time during the year. The other 113 (27%) reported their symptoms as becoming worse in certain months of the year. Most of them had worse symptoms from December to February. A total of 129 (30.8%) patients reported that their symptoms mainly occurred indoors, 269 (64.2%) reported that symptoms occurred both indoors and outdoors, and 21 (5%) reported that symptoms occurred only outdoors. Only four of 419 patients reported that their nasal symptoms appeared to be related to exposure to grass, tree, or other plants, and skin tests were positive in three of them. A total of 200 (47.7%) patients reported

Table 2. Characteristics of pollen sensitive patients (*n* = 118)*

Characteristics	
Sex	
Female	51 (43.2)
Male	67 (56.8)
Symptom	
Intermittent	26 (22.0)
Persistent	92 (78.0)
Location	
At work	7 (5.9)
Indoors	38 (32.2)
Outdoors	5 (4.2)
Both indoors & outdoors	75 (63.6)
Impact on sleep	
None	16 (13.6)
Mild	44 (37.3)
Moderate	33 (28.0)
Severe	25 (21.2)
Impact on daily activities	
None	15 (12.7)
Mild	43 (36.4)
Moderate	35 (29.7)
Severe	25 (21.2)
Sensitive to perennial allergens	93 (78.8)
Symptoms appeared to be related to exposure to grass, tree or other plants	4 (3.4)
Age (yr)	27.92 ± 13.10
Symptoms scores	
Nasal obstruction	6.14 ± 3.12
Sneezing	5.94 ± 2.73
Rhinorrhea	6.11 ± 2.64
Itchy eyes and nose	5.49 ± 3.16

*Data presented as *n* (%) or mean ± standard deviation.

that nasal symptoms did not interfere with or only mildly interfered with sleep. The other 219 (52.3%) patients reported that nasal symptoms moderately or severely interfered with sleep. A total of 179 (47.5%) patients thought that their nasal symptoms had little or no impact on daily activities such as working, studying, or doing physical exercise. The other 220 (52.5%) thought that their nasal symptoms had a moderate to severe impact on their daily activities. However,

there were no significant differences among the four subgroups based on the variables described above (Table 1).

The mean symptom scores (standard deviation) of nasal obstruction, sneezing, rhinorrhea, and itchy eyes and nose, and mean total score were 6.09 (2.98), 5.91 (2.86), 5.94 (2.71), 5.22 (3.12), and 23.18 (8.14), respectively. There were no significant differences in scores for nasal obstruction, rhinorrhea, and itchy eyes and nose among the four subgroups, but the sneezing and total scores were significantly higher in patients who were sensitive to perennial allergens compared with those whose skin test was negative (group 2 *vs.* 4: *p* = 0.008, 0.014, respectively; group 3 *vs.* 4: *p* = 0.024, 0.015, respectively) (Table 4).

Discussion

Our results showed that most AR patients in Taiwan are allergic to perennial allergens. The warm, humid climate in Taiwan is believed to result in the high prevalence of mite allergy that is found throughout the population. The rate of sensitivity to cockroach mix in our study was as high as that described in a previous study on Taiwanese asthma patients.¹⁰ Among patients with pollen allergy, most of them were also sensitive to perennial allergens. Only 25 of 419 patients were sensitive to pollen alone. A skin test of 977 patients with chronic rhinitis in Hong Kong, another subtropical island situated on the southeast coast of Asia, has yielded similar results.¹¹ In that study, 651 (67%) patients had a positive skin test using a six-item panel. The rates of sensitivity to mites (Der p and Der f) and cockroach mix were 63% and 23%, respectively. They also reported a 4% rate of sensitivity to pollen mix (a mixture of *Avena*, *Hordeum*, *Triticum*, *Dactylis*, *Festuca*, *Lolium*, *Phleum*, *Poa*, *Cynodon dactylon*, and *Phragmites communis*).

The most common pollen allergens in our results were spiny pigweed, Johnson grass, and sheep sorrel. They are native species from the Mediterranean region, tropical America, and Eurasia but are present in most continents.¹² They were introduced

Table 3. Prevalence of allergens in 419 patients

Allergen	n (%)	Rank
Perennial allergens		
Dust, house mixture	164 (39.1)	3
<i>Dermatophagoides pteronyssinus</i>	214 (51.1)	2
<i>Dermatophagoides farinae</i>	246 (58.7)	1
Dog epithelium	16 (3.8)	
Cat hair	37 (8.8)	
Cockroach, mix (American cockroach, German cockroach)	151 (36)	4
<i>Candida albicans</i>	59 (14.1)	5
Pollen allergens		
Tree pollens		
Acacia (<i>Acacia</i> spp.)	4 (1)	
Pine mix (loblolly, white/eastern, yellow pines)	2 (0.5)	
Eucalyptus (<i>Eucalyptus globulus</i>)	5 (1.2)	
Beefwood (<i>Casuarina equisetifolia</i>)	7 (1.7)	
Juniper mix (one-seed juniper, Rocky Mountain juniper)	10 (2.4)	
Willow (<i>Salix nigra</i>)	2 (0.5)	
Mulberry mix (red and white Mulberry)	7 (1.7)	
Pepper tree (<i>Schinus</i> spp.)	18 (4.3)	
Red cedar (<i>Juniperus virginiana</i>)	4 (1)	
Grass or weed pollens		
Johnson grass (<i>Sorghum halepense</i>)	42 (10)	7
Bermuda (<i>Cynodon dactylon</i>)	9 (2.1)	
Ragweed mix (giant ragweed, short ragweed)	3 (0.7)	
Timothy grass (<i>Phleum pratense</i>)	11 (2.6)	
Spiny pigweed (<i>Amaranthus spinosus</i>)	49 (11.7)	6
Cocklebur (<i>Xanthium strumarium</i>)	17 (4.1)	
Sage mix (common sagebrush, prairie sage)	20 (4.8)	
Sheep/red sorrel (<i>Rumex acetosella</i>)	38 (9.1)	8
Dog fennel (<i>Eupatorium capillifolium</i>)	5 (1.2)	
Pigweed mix (careless weed/green amaranth, Palmer amaranth, rough/redroot pigweed)	5 (1.2)	
English plantain (<i>Plantago lanceolata</i>)	5 (1.2)	
Others		
Castor bean (<i>Ricinus communis</i>)	17 (4.1)	
Alfalfa (<i>Medicago sativa</i>)	13 (3.1)	
Dandelion (<i>Taraxacum officinale</i>)	7 (1.7)	

to Taiwan a long time ago.¹³ All are perennial weeds that are seen widely around the island. A survey of airborne pollen grains has been conducted by National Taiwan University during 1993–1995. They have reported that *Broussonetia* pollens were the most common captured aeropollens in Taiwan.^{14–16} However, the association between *Broussonetia* pollens and allergic diseases in Taiwan has not been studied in the past. There was

no commercialized and standardized *Broussonetia* allergen available during our study period. In western countries, weed or grass pollens that cause most allergies are mugwort, ragweed, *Parietaria* and Bermuda grasses. Trees such as birch, ash, olive, oak, cypress, juniper, thuja, Japanese cedar and mountain cedar are responsible for pollinosis in western countries.¹ Only one case of pollinosis to *Broussonetia papyrifera* has been reported in Italy.¹⁷

Table 4. Correlation of symptom severity with results of skin test*

Symptom score	Skin test [†]				P
	Pollens (n = 25)	Perennial allergens (n = 194)	Both (n = 93)	Negative (n = 107)	
Nasal obstruction	5.32 ± 3.44	6.21 ± 2.91	6.37 ± 3.02	5.81 ± 2.94	0.312
Sneezing	5.84 ± 3.00	6.19 ± 2.67	6.18 ± 2.55	5.32 ± 2.78	0.049
Rhinorrhea	5.48 ± 2.97	6.20 ± 2.79	6.06 ± 2.67	5.37 ± 3.06	0.105
Itchy eyes and nose	4.88 ± 3.63	5.22 ± 3.11	5.66 ± 3.03	4.93 ± 3.08	0.395
Total	21.52 ± 9.78	23.84 ± 7.84	24.27 ± 8.05	21.44 ± 8.13	0.037

*Data presented as mean ± standard deviation; [†]Results of skin test were divided into four groups: (1) sensitive to pollen allergens alone; (2) sensitive to perennial allergens alone; (3) sensitive to pollen and perennial allergens; and (4) negative.

The size of pollen varies from 10 to 100 µm. Pollen can deposit in the nostrils and eyes to induce symptoms of allergic rhinoconjunctivitis. Pollen grains can also emit respirable particles that can penetrate into the lower airways where they can trigger asthmatic responses.¹ Pollen contains nicotinamide adenine dinucleotide phosphate (reduced) oxidases and bioactive lipid mediators that probably contribute to the inflammatory response.¹⁸ A number of studies have attempted to evaluate the correlation between prevalence of pollen and allergic diseases.^{19–22} However, the findings were confounded by several factors including pollutants, multi-sensitivity, and time lag between exposure to pollen and nasal symptoms. The nature and number of pollens also vary with geography, temperature, and climate. In Taiwan, there is an abundance of pollen-producing plants throughout the year, the prevalence of mite allergy is high, and the air is highly polluted. Therefore, it is difficult to adjust properly for all the potential confounders and establish causal relationships between pollen and clinical symptoms in AR patients.²³

In this study, there were no differences among the four subgroups with regard to intermittent versus persistent symptoms, indoor versus outdoor symptoms, and whether or not symptoms interfered with sleep or daily activities. Even in patients who were sensitive to pollen alone, symptoms were persistent and occurred indoors in most cases. This finding indicates that in Taiwan, other factors such as pollutants might play an important role in inducing symptoms in patients

with pollen allergy. All symptoms tended to be more severe in patients who were sensitive to perennial allergens, with or without pollen allergens, than in patients who were sensitive to pollen allergens alone, although the differences were not significant (Table 4). These results suggest that pollens are not important allergens for most AR patients in Taiwan.

In conclusion, our results show that most AR patients in Taiwan are sensitive to perennial allergens. Pollen is a less common cause of sensitization among rhinitis patients in Taiwan. However, the role of pollen in AR patients who are living in subtropical regions requires further investigation.

Acknowledgments

We are grateful to the Biostatistics Task Force, Taichung Veterans General Hospital, Taichung, Taiwan, for its assistance with the statistical analyses.

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