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Prevalence and clinical features of pollen-food allergy syndrome in adults with seasonal allergic rhinitis

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Abstract. – OBJECTIVE: Pollen-food allergy syndrome (PFAS) is an IgE-mediated allergic reaction to certain foods due to prior sensitization to pollen allergens. The data about the prevalence of PFAS in adults in Turkey is not sufficiently reported. Our objective was to investigate the frequency and clinical features of PFAS in adult patients with seasonal allergic rhinitis (SAR).

PATIENTS AND METHODS: A total of 222 patients with SAR were enrolled in our outpatient allergy clinic at Hacettepe University, during a ten-month period. A questionnaire was used to evaluate patients and to categorize those who experienced obvious allergy symptoms consistent with PFAS. Atopy was assessed by a standard skin prick test panel including common aeroallergen extracts.

RESULTS: Among 222 patients with a diagnosis of SAR, 31 had patient reported PFAS (31/222, 14%). Among them, 23 (74.2%) were females, and their mean age was 32.29±9.24 years. The most common symptoms were isolated oropharyngeal symptoms (58.1%), followed by urticaria (51.6%) after culprit food ingestion. The most frequent culprit foods were eggplant, walnut, kiwi, peach, and melon. The predominant sensitizing aeroallergen was grass pollen.

CONCLUSIONS: PFAS can be frequently observed in adults who are followed up for SAR. The most frequently involved foods are eggplant, walnut, kiwi, peach, and melon in Ankara Province. The symptoms of PFAS are usually localized in the oropharyngeal area and are self-limited.

Key Words:
Pollen food allergy syndrome, Seasonal allergic rhinitis, Prevalence, Turkey.

Introduction

As the prevalence of seasonal allergic rhinitis (SAR) rises, related food allergies are also becoming an increasing health issue[1,2]. In adolescents and adults, 30-60% of food allergies are related to pollen allergy and are termed pollen-food allergy syndrome (PFAS)[3]. PFAS is an IgE-mediated allergic reaction and is also known as pollen-related food allergy. IgE, which develops in response to tree, grass, and weed pollens, binds to proteins in foods such as fruits, vegetables, and nuts, causing the development of various allergic reactions[3]. One or more target organs may be affected, including the oral mucosa, skin, gastrointestinal and respiratory tracts, and cardiovascular system. Contact urticaria of the oropharyngeal sites is the most common form of food allergy observed in adolescents and adults[4]. However, more severe systemic symptoms such as anaphylactic reactions are also seen in PFAS patients[5]. Differences in study criteria, definitions used, population studied, and geographic location affect the prevalence of PFAS. In some studies[6-10] the prevalence of PFAS in children was between 4.7% and 20%, it was found to be between 13% and 53.8% in adults.

There are a few studies[11-13] investigating the frequency of PFAS in Turkey. The main objective of the present study was to assess the frequency of patient reported PFAS in adult patients with SAR in Ankara, Turkey. In addition, the clinical features of PFAS were evaluated, and patients with and without PFAS were compared.

Patients and Methods

In total, 222 patients with SAR were included in our outpatient allergy clinic at Hacettepe University, during a ten-month period. The data about demographic features, accompanying atopic diseases, types of allergic reactions after ingestion of foods, history of familial atopic diseases, and related health history were obtained by allergists by filling in a questionnaire face-to-face. Patients were categorized as having PFAS if they experienced overt allergy symptoms consistent

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with PFAS (pruritus and angioedema of the oropharyngeal sites, or systemic symptoms, such as urticaria, respiratory and gastrointestinal symptoms, anaphylaxis) shortly after consuming typical pollen-related foods. Patients underwent skin prick tests (SPT) with standardized aeroallergen extracts (ALK Albello, Hørsholm, Denmark; Allergopharma, Wentorf, Germany) for the following 13 common aeroallergens (*Dermatophagoides pteronyssinus, Phleum pratense, Artemisia vulgaris, Parietaria officinalis, Corylus avellana, Betula verrucosa, Olea europae*, cat, dog, *Alternaria alternata, Cladosporium herbarum, Aspergillus fumigatus,* cockroach). SPT results were evaluated after 20 minutes. Histamine (10 mg/mL) was used as a positive control, and saline was used as a negative control. SPT results were considered positive if at least one of the allergens caused a wheal size of ≥3 mm. SPTs were administered by the same trained nurse. SPTs were not performed in cases of using drugs that have suppressant effects on immediate skin testing[14].

Statistical Analysis

The statistical analysis was performed using the SPSS program version 21.0 (IBM Corp., Armonk, NY, USA). Categorical variables were presented as numbers and percentages. For data that showed a normal distribution, the values were expressed as means and standard deviation (SD), and for data that did not, they were presented as medians (minimum-maximum). The categorical variables were compared using the Chi-square test, the non-normally distributed continuous variables were compared using the Mann-Whitney test, and the normally distributed continuous data were compared using the independent *t*-test. A p-value <0.05 was considered statistically significant.

Results

A total of 222 patients with SAR, including 137 females (61.7%) and 85 males (38.3%), with a mean age of 32.24±9.99 (min-max: 17-68) years were included in this study. The mean age of the onset of the SAR was 23.11±11.01 years. Sensitization to grass pollen (*Phleum pratense*), weed pollens (*Artemisia vulgaris, Parietaria officinalis*), tree pollens (*Corylus avellana, Betula verrucosa, Olea europae*) was detected in 124 (124/198, 62.6%), 29 (29/198, 14.6%), and 25 (25/198, 12.6%) patients, respectively.

Forty-five patients stated that they have had food allergies. Among 222 patients with a diagnosis of SAR, 31 had patient reported PFAS (31/222, 14%). Among them 23 were females, and the mean age was 32.29±9.24 years for the whole group. The remaining 14 patients had other food allergies not related to PFAS (e.g., egg, cow's milk, etc.). The most common symptoms were isolated oropharyngeal symptoms (58.1%), followed by urticaria (51.6%) after the ingestion of the suspected food. The culprit fruit was a peach, and SPT was negative in the only patient with a history of anaphylaxis. The predominant sensitizing aeroallergens were grass pollen (14/29, 48.3%), followed by tree pollens (5/29,17.2%) and weed pollens (5/29, 17.2%). Of the 31 patients with PFAS, 13 (41.9%) had asthma, 4 (12.9%) had drug allergy, and 2 (6.5%) had atopic dermatitis. None of the patients had venom allergy or latex allergy. Twenty-six patients (83.9%) had a history of familial atopic diseases and only one patient had a history of familial food allergy. Clinical features of patients with PFAS are shown in Table I.

Table I. Clinical features of patients with pollen-food allergy syndrome (n=31).

Gender, n (%)	
Female	23 (74.2)
Age (year)	
mean±SD	32.29±9.24
Age at onset of SAR (year)	
mean±SD	22.77±11.39
Allergic comorbidities, n (%)	
Asthma	13 (41.9)
Atopic dermatitis	2 (6.5)
Drug allergy	4 (12.9)
Clinical symptoms, n (%)	
Isolated oropharyngeal symptoms	18 (58.1)
Urticaria	16 (51.6)
Respiratory symptoms	5 (16.1)
Gastrointestinal symptoms	2 (6.5)
Anaphylaxis	1 (3.2)
Aeroallergen sensitization, n (%)	29 (100)
Pollen (total)	14 (48.3)
Animal dander (cat, dog)	6 (20.7)
House dust mite (D. pteronyssinus)	4 (13.8)
Mold	2 (6.9)
Total IgE (IU/mL)	
Median (min-max)	218 (5-1627)
Percentage of eosinophils (%)	
Median (min-max)	2.4 (0.6-16.7)
Atopic diseases in family, n (%)	26 (83.9)
Food allergy in family, n (%)	1 (3.2)

Table II. Comparison of the features of patients with or without pollen-food allergy syndrome.

	PFAS positive (n=31)	PFAS negative (n=191)	p
Gender, n (%)			
Female	23 (74.2)	114 (59.7)	0.123
Age (year)			
Mean±SD	32.29±9.24	32.23±10.14	0.974
Age at onset of SAR (year)			
Mean±SD	22.77±11.39	23.17±10.97	0.854
Asthma in history, n (%)	13 (41.9)	67 (35.1)	0.461
Atopic dermatitis in history, n (%)	2 (6.5)	10 (5.2)	0.677
Atopic diseases in family, n (%)	26 (83.9)	126 (66.0)	**0.047**
Total IgE (IU/mL)			
Median (min-max)	218 (5-1,627)	103 (2-2,758)	0.099
Percentage of eosinophils (%)			
Median (min-max)	2.4 (0.6-16.7)	3 (0-22.7)	0.943
Pollen sensitization, n (%)	29 (100)	169 (100)	
Grass pollen	14 (48.3)	110 (65.1)	0.084
Weed pollens	5 (17.2)	24 (14.2)	0.776
Tree pollens	5 (17.2)	20 (11.8)	0.378

PFAS: Pollen-food allergy syndrome.

Patients with and without PFAS did not differ significantly in terms of gender, age, or age at the onset of SAR. Atopic disorders in family history were more common in patients with PFAS (83.9% *vs.* 66%, $p = 0.047$). The frequency of asthma and atopic dermatitis, pollen sensitization rates, total IgE levels and eosinophil percentages in the serum were similar in the patients with and without PFAS. Comparison of the patients with or without PFAS is shown in Table II.

The most common culprit foods were eggplant (*solanaceae*), walnut (*juglandaceae*), kiwi (*actinidiaceae*), peach (*rosaceae)*, and melon (*cucurbitaceae*), respectively. In other plant families, the number of patients was equal or less than four. Fourteen (14/29, 48.3%) patients had evidence of pollen sensitization shown by SPTs, and among them, 7 patients' SPT results were compatible with the responsible pollens cross-reacting with the culprit foods. Culprit plant families and foods triggering symptoms in patients with PFAS are shown in Table III.

Table III. Culprit foods and plant families in patients with pollen food allergy syndrome (n=31).

Plant family	n (%)
Solanaceae	
eggplant	8 (25.8)
tomato	2 (6.5)
potato	1 (3.2)
Juglandaceae	
walnut	5 (16.1)
Actinidiaceae	
kiwi	4 (12.9)
Rosaceae	
peach	3 (9.7)
plum	2 (6.5)
apricot	1 (3.2)
Cucurbitaceae	
melon	3 (9.7)
watermelon	1 (3.2)
Asteraceae	
sunflower	2 (6.5)
Liliaceae	
onion	2 (6.5)
garlic	1 (3.2)
Fabaceae	
peanut	2 (6.5)
Brassicaceae	
arugula	1 (3.2)
cress	1 (3.2)
Vitaceae	
grapes	1 (3.2)

Discussion

In our study, 222 patients with SAR were evaluated, and the prevalence of PFAS was found to be 14%. While isolated oropharyngeal symptoms were the most common in PFAS patients, only one patient reported peach-induced anaphylaxis.

The most frequent causative food in PFAS was eggplant. To the best of our knowledge, our research is the second study showing the frequency of PFAS and related foods in adults in central Anatolia in Turkey.

PFAS is the most frequent type of food allergy in adults[15-18]. Contact urticaria of the oropharyngeal region was first described as an oral allergy syndrome (OAS). Some experts continue to use the terms OAS and PFAS synonymously[19,20]. Because of the distinction between PFAS and OAS and also the different populations studied, prevalence rates vary. In a population-based study conducted by Gupta et al[21] in 40,000 American adults, the prevalence of food allergy was found to be 10.8%. According to research[22] conducted by US allergists, the prevalence of food allergy in children and adults with pollen allergy was found to be 5% and 8%, respectively. It is generally assumed that 30-60% of European patients with food allergy also have a related pollen allergy[3]. PFAS is more common in northern Europe due to birch pollen allergy. Over the last few decades, birch pollen sensitization has increased, and the majority of patients with birch pollen allergy suffer from PFAS[23]. In one study, 40-50% of birch-allergic patients were reported to have PFAS[24]. The prevalence of PFAS ranged from 7.5% to 41.4% in southern European countries[11]. According to some studies[25-29] using different criteria: 20%-70% of patients with pollen allergy have pollen-related food allergy; nearly 20% of the patients who underwent SPT; 45% of patients with SAR; and 26%-34% of patients with eosinophilic esophagitis have PFAS. In a previous study[12] performed in our country, the prevalence of PFAS in adults with SAR was observed to be 19.3%. The results of our study are in line with the results of a recent study[12] on adults in our country.

As the prevalence of PFAS varies due to the different distribution of pollen around the world, the food they are associated with also varies according to geographical regions[17]. While apple is the most frequently associated food with PFAS in central and northern European countries, kiwi, peach, and melon were most commonly associated in southern European countries[11,18]. In our country, peach was reported to be the most common associated food in children, whereas kiwi, peach, tomato, melon, and watermelon were reported to be the most common associated foods in adults with PFAS[12,13]. A recent multicenter study[11] by Izmir center conducted in nine study centers in seven southern European countries, including Turkey, reported that kiwi has been the most common triggering food, while Istanbul center reported that reactions to almond have been common. In our study, it was found that the most frequently related foods were eggplant, walnut, kiwi, peach, and melon. It was determined that more patients described a reaction to eggplant compared to other foods. Eggplants are produced mainly in southeast Asian countries like China and India, but Turkey is also in second-line producer countries[30,31]. In addition, eggplant contains 48 proteins that have the potential to cause an allergic reaction through more than four mechanisms[32,33]. Allergic reactions to eggplant have been reported in association with grass pollen allergy[15]. The fact that eggplant was found to be the most common trigger food in our study can be explained by our country's high production, resulting in high consumption and eggplant's high allergy potential.

In PFAS, symptoms develop between a few seconds and 5-10 minutes after raw food consumption. Individuals with PFAS can consume cooked or processed foods without any symptoms. Symptoms are often mild and localized in the oropharyngeal sites, such as itching of the oropharynx, nose, and/or ear, and tightness of the throat. In the study by Ma et al[22], 97% of PFAS patients had such symptoms, while systemic symptoms developed without oropharyngeal symptoms in 3% of patients. In studies[5,34] including patients with PFAS, systemic symptoms such as generalized urticaria, respiratory symptoms, and anaphylactic shock have been reported to be 1-8%. In the present study isolated oropharyngeal symptoms (58.1%) were the most common. In the research by Kim et al[5], several risk factors were identified for the occurrence of anaphylactic reactions: the type of food (almonds, apricots, cherries, celery, lentils, peaches, plums, and tomatoes), the number of foods, a high level of sensitization to these foods, and associated allergic dermatitis. One of our patients who described an anaphylactic reaction to peach did not have concomitant atopic disease.

The frequency of patient reported PFAS was 14% in our study sample, where 62.6% of participants were sensitive to grass pollen, 14.6% to weed pollen, and 12.6% to tree pollen. The frequency of PFAS was 20%, 17.2% and 11.3% in tree, weed and grass pollen sensitized patients, respectively. Although the highest rate was in tree sensitization, no significant difference was detected between pollen sensitizations. Osterballe et al[35] and Özdemir et al[12] reported that sensitization to tree pollen was associated with a higher rate of PFAS than sensitization to weed or grass pollen.

In different studies conducted on adults in our country, different risk factors associated with PFAS were reported. Çalışkaner et al[36] reported female gender, older age, and asthma as risk factors for PFAS, and Özdemir et al[12] reported asthma and tree pollen sensitization. In a previous study[37] conducted in our outpatient clinic, dermatological symptoms, duration of rhinitis > 5 years, duration of symptoms > 3 months in a year, and SPT reactivity to *Artemisia vulgaris*, *Betula verrucosa,* and *Corylus avellena* were found to be risk factors for the emergence of food hypersensitivity in cases with SAR. However, there are also studies[38] conducted on adults stating that there was no relationship between age, gender, and asthma and PFAS. In our study, when the patients with and without PFAS were compared in terms of age, gender, concomitant asthma and atopic dermatitis, and pollen sensitization, no significant difference was found between the two groups, while patients with PFAS had significantly more atopic diseases in their family history ($p = 0.047$).

A comprehensive anamnesis is essential for the diagnosis of PFAS. Combining anamnesis with SPT and an open/blind oral food challenge enhances the diagnosis[39]. PFAS should be considered in patients who are admitted to an allergy clinic with oropharyngeal symptoms and pollen allergy. Firstly, SPT is performed with standardized allergen extracts. If the results are negative, the test can be repeated or a prick-by-prick test can be performed with fresh food. Sensitivity of SPT and *in vitro* specific IgE measurements is 70-80%, while specificity is 40-70%[40]. Component-resolved diagnostics based on targeting specific IgE measurements against individual allergenic molecules can reveal pan-allergenic proteins that cause PFAS. Another molecular test is the basophil activation test; however, the cost of these tests is high, and their use is still limited and requires a specialized laboratory[41]. A double-blind oral challenge test can be done when the responsible food cannot be found, and surety is desired. In our study, the diagnosis of PFAS was made with a clinical history obtained by questionnaire, and SPT.

Limitations

Our study has some limitations. In our patients, we did not conduct a food challenge test to confirm the diagnosis. However, the study population had reliable clinical history that developed immediately after culprit food consumption. As prick-by-prick tests required fresh food at the clinic and molecular tests required a specialized laboratory, these tests could not be performed.

Conclusions

PFAS is frequently observed in patients with SAR in a tertiary allergy center in Ankara, Turkey. The most frequently involved foods in patients with PFAS were eggplant, walnut, kiwi, peach, and melon. Because the symptoms are mild and self-limited, patients can tolerate the symptoms most of the time, and they do not associate the symptoms with pollen allergy. Therefore, it is important to obtain complaints with specific questions throughout the clinical history. In the management of PFAS, patients should avoid trigger foods. An adrenaline autoinjector should be recommended for patients with a history of anaphylaxis.

Conflict of Interest

The authors declare that they have no potential conflicts of interest.

Ethics Approval

The study protocol was approved by the Ethics Committee of Hacettepe University (GO 14/495-33). The study was conducted in accordance with the principles of the Declaration of Helsinki.

Informed Consent

All participants were informed about the nature of the study and informed consent was obtained from all individual participants included in the study.

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Authors' Contribution

All authors contributed substantially to conception and design, or acquisition of data, or analysis and interpretation of data; drafting the article or revising it critically for important intellectual content; and final approval of the version to be published.

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