

ORIGINAL ARTICLE

The prevalence of the oral allergy syndrome and pollen-food syndrome in an atopic paediatric population in south-west Sydney

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Aim: Oral allergy syndrome (OAS) and pollen-food syndrome (PFS) are regarded as uncommon manifestations of paediatric atopic disease. However, little Australian data exist. The aim of this study was to examine the prevalence of OAS in an atopic, paediatric population.

Methods: This cross-sectional study assessed 163 patients aged 4–17 years from the Paediatric Allergy & Immunology Clinic at Campbelltown Hospital, which serves a population base >250 000 with approximately 28% under the age of 18 years. A questionnaire was administered and skin prick tests (SPTs) were performed utilising commercial extracts and fresh and frozen fruit samples. Frozen samples were created by reducing fresh fruit to a semi-solid state and storing at –20 degrees Celsius for up to 6 months.

Results: Within the studied population, the prevalence of OAS was 14.7%, PFS 4.9%, PFS in those with allergic rhinitis 6.25% and PFS in those with allergic rhinitis and pollen sensitisation 12.1%. All PFS-implicated fruits were tropical fruits with watermelon the most common. The prevalence of OAS caused by food allergy was 13.6%, implicating peanut most frequently. The most common cause of OAS was immunoglobulin E-mediated food allergy (57.9%). Only frozen samples of watermelon, pineapple and rockmelon produced results consistent with the 'gold standard' of fresh fruit SPT.

Conclusion: This study suggests the prevalence of OAS and PFS are more common in paediatric populations than previously described, with tropical fruits predominantly implicated in PFS. Further research is required to determine whether frozen fruits are a reliable alternative to fresh fruit in SPT.

Key words: food allergy; oral allergy syndrome; paediatric allergy; pollen food syndrome.

What is already known on this topic

- 1 Limited epidemiological studies investigating oral allergy syndrome (OAS) and pollen-food syndrome (PFS) in paediatric populations exist. OAS and PFS are generally considered uncommon manifestations of paediatric atopic disease.
- 2 In paediatric populations, OAS and PFS are considered to be predominantly found in adolescent populations.
- 3 Nearly all published studies describe the pollen and food cross-reactivity patterns in relation to regions within the northern hemisphere. The birch-apple syndrome is most commonly described.

What this paper adds

- 1 The prevalence of OAS in this atopic paediatric population was 14.7% with the most common cause of OAS being immunoglobulin E-mediated food allergy.
- 2 The prevalence of food allergy manifesting with OAS was 13.6%, with peanut most frequently implicated.
- 3 The prevalence of PFS was 4.9%, affecting males and females equally with their ages ranging from 7 to 15 years. The most commonly implicated foods were tropical fruits of which watermelon was the most common.

Oral allergy syndrome (OAS) is defined by the presence of characteristic oropharyngeal signs and symptoms. Symptoms are produced upon contact with an implicated food and include labial and oropharyngeal pruritus, paraesthesia, angioedema of

the oral mucosa, tongue, palate and oropharynx, itchy ears and laryngeal tightness causing hoarseness.^{1–8} Previously, OAS was considered synonymous with pollen-food syndrome (PFS), causing difficulties in description and application of different studies. In this study, OAS is considered a collection of symptoms, which may have different aetiologies including PFS, food allergy (FA) or latex-fruit syndrome.

PFS is an immunoglobulin E (IgE)-mediated allergic response resulting from primary sensitisation to an aeroallergen and subsequent cross-reactivity between epitopes on pollen proteins and those found on plant-derived food proteins. Frequently implicated foods include raw fruits, vegetables, legumes and

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spices.^{5–10} Classically, PFS presents with isolated OAS. However, approximately 10% of PFS presentations are associated with systemic symptoms and 1–2% with anaphylaxis.^{6,7} As plant-derived proteins such as pathogenesis-related proteins and profilins are typically heat labile and unstable to digestive enzymes, heating or cooking results in reduced or absent OAS symptoms.^{1,2,5} Some proteins, such as lipid transfer proteins, are more heat stable and therefore often associated with OAS and systemic or anaphylactic reactions.^{1,2,5}

Currently, limited epidemiological studies investigating OAS and PFS in both paediatric and adult populations exist. European data estimate that OAS occurs in 47–70% of pollen-allergic adult patients,² while American data estimate the prevalence to be 8%.¹¹ Based on few studies from Europe⁴ and the United States,¹¹ OAS and PFS have been regarded as uncommon manifestations of paediatric atopic disease with a reported prevalence of 1–5%. However, one European study¹² suggested OAS may be more prevalent in childhood than previously recognised. Prevalence determinations are influenced by geographical pollen distribution, dietary influences or habits, and regional prevalence of atopic disease.^{2,13} No epidemiological evidence is available for populations from the southern hemisphere.

Although no ‘gold standard’ for diagnosis of OAS or PFS exists, the use of clinical history, supplemented with skin prick testing (SPT), is widely supported in the literature by meta-analyses and clinical trials.^{14,15} Determination of the aetiological process causing OAS requires further investigation.

In OAS, SPTs may be of value through assessing aeroallergen sensitisation and identification of cross-reactive patterns. Furthermore, absence of pollen sensitisation may suggest another aetiology. The higher sensitivity and specificity of fresh fruit SPTs compared with SPTs using commercial extract have been extensively documented.^{16,17} Fresh fruit SPTs using the prick-prick method^{16,17} is considered the standard for diagnosis of fruit or vegetable sensitisation.^{17,18} Recent research has reported that freezing fruit for up to 2 years does not appear to alter their antigenic properties.^{18,19} Frozen fruit may therefore provide a reliable and more convenient alternative to fresh fruit in SPT.

The aim of this study was to examine the prevalence of both OAS and PFS in an Australian atopic, paediatric population. A secondary aim was to assess the reliability of frozen fruit samples in SPTs compared with fresh fruit in those with PFS.

Methods

Patients

Every patient aged between 4 and 17 years with atopic disease including atopic rhinoconjunctivitis, atopic dermatitis, atopic asthma or FA reviewed at Campbelltown Hospital Paediatric Allergy & Immunology Outpatient Clinic between June 2011 and May 2012 was recruited into this study. Patients aged less than 4 years and those unable to provide history sufficient for assessment of the presence/absence of OAS were excluded. Patients without evidence of atopic disease were excluded. Patients who were reviewed more than once during this period were recorded once.

The OAS and PFS in paediatric populations questionnaire

A questionnaire was devised and administered to every eligible patient by an allergy specialist or allergy clinical nurse consultant. Prior to administration, parents and guardians were informed that data collected would be stored in a secure, de-identified form. The questionnaire functioned as a framework for investigators to identify and record demographic data, history of atopic disease, and presence of OAS, its symptoms and implicated foods for every patient reviewed meeting inclusion criteria.

Diagnosis of OAS

Patients reporting oropharyngeal symptoms such as itching, tingling, stinging, numbness or swelling of the lips, tongue, palate, mouth or throat upon immediate contact, biting and chewing, or within 5 min of ingestion of the implicated food were diagnosed with OAS. Patients reporting both isolated OAS and OAS associated with other systemic features were included in this group.

Skin prick testing

Patients diagnosed with OAS on history underwent relevant SPTs to pollen and food.

Histamine phosphate (10 mg/mL) and glycerosaline were used as the positive and negative controls, respectively. A positive SPT response was taken as a wheal >3 mm.

The relevant pollen allergens were determined using a panel relevant to the region including grasses – perennial rye, timothy, bermuda, bahia; weeds – plantain, dock/sorrel; and trees – eucalyptus, birch mix, plane tree, pine, acacia (Hollister-Stier, Spokane, WA, USA and Stallergenes, Anthony, France). In addition, apple, peach and profilin extracts (ALK-Abello, Horshom, Denmark) were included to represent the commonly described cross-reactive proteins. SPTs were performed as per standard procedures.^{16,17} Patients with documented SPT results to pollen allergens performed within the last 18 months were not retested. In some young patients, not all pollen allergens were tested as a positive response to any pollen allergen was considered sufficient evidence of pollen sensitisation.

When indicated by a clinical history of OAS, patients underwent SPTs for the specifically implicated food(s). Common foods including egg white, egg yolk, cows milk, wheat, soybean, peanut, almond, cashew, hazelnut, pecan and macadamia were tested with commercial extracts (Hollister-Stier, Stallergenes or ALK-Abello). Fruits were tested by employing the prick-prick method¹⁷ using fresh and frozen fruit samples of the implicated food. Patients were advised to bring any implicated vegetable(s) for testing.

Fresh and frozen fruit samples

Prior to SPTs, the relevant fresh fruits were obtained. The frozen fruit samples were created by reducing fresh fruit to a semi-solid state. They were stored in clearly labelled ice-cube trays. All equipment used was sterilised with boiling water, cooled and dried in order to avoid contamination and destruction of the

allergens. These frozen samples were stored in a refrigerator at -20 degrees Celsius for a period up to 6 months.

Statistical analysis

Results were tabulated and entered into SPSS (SPSS, Inc., Chicago, IL, USA). Using SPSS, a frequency report was used to determine prevalence. Because of the small sample size of patients with diagnosed PFS, formal statistical analysis of the correlation between fresh and frozen fruit SPT results was not possible. Descriptive results were provided.

Results

Demographics

In this study, 163 paediatric patients aged between 4 and 17 years were assessed, 62% were male, with a median age of 8 years.

Prevalence of atopic disease

The prevalence of atopic disease within the study population is described in Table 1.

In this study, 28.2% of patients had one allergic disease manifestation, 36.8% had two, 22.1% had three and 12.3% had four allergic disease manifestations.

Of the 112 patients with allergic rhinitis, 58.9% (66 patients) were sensitised to pollen, 35.7% (40 patients) were not and 5.4% (6 patients) had incomplete or missing SPT data. Those patients with allergic rhinitis (AR) and no evidence of pollen sensitisation were sensitised to dust mite, animal and/ or mould allergens.

OAS

Utilising clinical history guided by questionnaire items, 24 of the 163 patients (14.7%) reported a history of OAS.

PFS

Of the 24 patients who reported OAS, 13 implicated fruits, vegetables and/or legumes as the causal food. All 13 patients had evidence of pollen sensitisation on SPTs. One patient with pollen sensitisation on SPTs denied symptoms of AR.

After assessment by SPTs utilising both fresh and frozen fruit samples, 8 of 13 patients demonstrated sensitisation to the implicated fruit and/or vegetable on fresh fruit SPTs. One of eight patients reported isolated OAS from peanuts and was SPT

positive on commercial peanut extract. From the remaining patients, one patient could not be tested because of severe extensive dermatitis and four patients did not demonstrate sensitivity to the implicated fruit on fresh fruit SPT. The demographics and foods implicated by these eight patients are shown in Table 2. Frequency of implicated foods confirmed on fresh fruit SPT is shown in Table 3.

PFS affected males and females equally (age range: 7–15 years; median: 11.2 years). Prevalence of PFS overall was 4.9%, 6.25% in those with AR and 12.1% in those with AR and pollen sensitisation.

FA

Of the remaining 11 patients, 10 reported OAS in association with either nausea, vomiting and abdominal pain and/or anaphylaxis. In this group, all demonstrated sensitisation to their implicated food (via commercial extract SPTs), the most common being peanut (seven patients), cashew (two patients), egg (two patients) and hazelnut (one patient). One patient reported OAS associated with systemic symptoms and anaphylaxis to both peanut and hazelnut. One patient reported isolated OAS upon contact with egg and no systemic symptoms. Four patients had AR. OAS was reported as a symptom in 13.6% (11/83 patients) of those with IgE-mediated FA; 57.9% of those with OAS were because of FA.

Fresh versus frozen fruit

The reliability of using frozen fruit samples compared with fresh fruit samples in SPTs for diagnosing patients with PFS was assessed during this study. The sample size of eight patients with diagnosed PFS proved too small to allow for formal statistical analysis. Descriptive results of the findings are presented in Table 3.

Discussion

In this study, 14.7% of an atopic paediatric population had OAS, which is more common than previously reported. However, this prevalence is affected by the consideration that OAS is not synonymous with PFS and can occur in association with systemic reactions. We found that OAS was more often present as a symptom of IgE-mediated FA rather than PFS, which is in contrast to findings in adult populations.¹¹ This difference is likely explained by the true prevalence of FA being significantly higher in children than adults.^{3,6,9} In this study, FA was more prevalent in the population than pollen-induced AR. Consequently, the difference in prevalence and natural history of atopic disease in children likely accounts for paediatric OAS being predominantly caused by IgE-mediated FA.

Increasingly, isolated OAS is recognised as an uncommon manifestation of IgE-mediated FA in the absence of pollen sensitisation.^{9,20,21} Mild oral reactions reported to progress to systemic or anaphylactic reactions are considered rare but have been associated with more stable proteins found in foods such as peanut.^{20,22} It is therefore essential that clinicians recognise the possibility that OAS may be caused by either FA or PFS and consider the risk of the implicated food when making management decisions.

Table 1 Prevalence of atopic disease within the study population

Allergic disease	Prevalence (%)
1a) Seasonal allergic rhinitis (SAR)	20.9
1b) Perennial allergic rhinitis (PAR)	47.9
1c) Any allergic rhinitis (SAR + PAR)	68.8
2) Atopic dermatitis (AD)	51.5
3) Atopic asthma (AS)	41.1
4) Food allergy (FA)	49.7

Table 2 Patient with PFS

Patient	Gender	Age (years)	Atopic disease	Pollen allergy with positive SPTs	Foods implicated on history	Confirmed by fresh fruit SPT
1	Male	15	PAR, AD, AS	Perennial rye, timothy, bermuda, paspalum, plaintain, dock/sorrel, eucalyptus, birch, plane tree, acacia, profilin	Fruit: Mango, orange, pineapple, rockmelon, watermelon Vegetable: Nil Legume: Nil	Mango, orange, pineapple, rockmelon, watermelon
2	Female	13	PAR, AD, AS	Perennial rye, timothy, bermuda, paspalum	Fruit: Kiwi fruit, pineapple Vegetable: Nil Legume: Nil	Kiwi fruit
3	Male	13	SAR, AD, AS, FA	Perennial rye, plaintain, birch, acacia	Fruit: Apple, avocado, banana, kiwi fruit, watermelon Vegetable: Carrot Legume: Nil	Kiwi fruit, watermelon
4	Female	12	AD, AS	Perennial rye, timothy, bermuda, paspalum, plaintain, birch, acacia	Fruit: Banana, kiwi fruit, watermelon Vegetable: Nil Legume: Nil	Kiwi fruit, watermelon
5	Male	11	SAR, AD, FA	Perennial rye, timothy, bermuda, birch, profilin	Fruit: Watermelon Vegetable: Nil Legume: Nil	Watermelon
6	Female	10	SAR, AS	Perennial rye, timothy, bermuda, paspalum, plaintain, dock/sorrel, birch, plane tree, acacia	Fruit: Banana, kiwi fruit, mandarin, orange, pineapple, watermelon Vegetable: Nil Legume: Nil	Banana, orange, watermelon
7	Female	9	PAR, AS, FA	Perennial rye, timothy	Fruit: Avocado, banana, mango Vegetable: Cucumber Legume: Peanuts	Banana Peanuts (tested by commercial extract only)
8	Male	7	PAR, AD, AS, FA	Perennial rye, bermuda, paspalum	Fruit: Mango, watermelon Vegetable: Nil Legume: Nil	Mango, watermelon

AD, atopic dermatitis; AS, atopic asthma; FA, food allergy; PAR, perennial allergic rhinitis; PFS, pollen-food syndrome; SAR, seasonal allergic rhinitis; SPT, skin prick testing.

Table 3 Foods implicated in PFS and tested with fresh and frozen fruits

Fruit	Number of patients positive to fresh fruit SPT	Number of patients positive to frozen fruit SPT	Number of patients with positive fresh SPT and negative frozen SPT results
Watermelon	6	6	0
Kiwi fruit	3	1	2
Banana	2	0	2
Mango	2	0	2
Orange	2	1	1
Pineapple	1	1	0
Rockmelon	1	1	0
Total	17	10	7

PFS, pollen-food syndrome; SPT, skin prick testing.

The prevalence of PFS was 4.9%, which is remarkably similar to prevalence estimates from the United States with 4.3%²³ and

5% (OAS in pollen allergic patients)¹¹ quoted in separate studies. Presently, there are no comparable European prevalence estimates. The prevalence of PFS in an atopic Australian paediatric population is therefore also more common than generally recognised.

In Northern and Central Europe, apple and hazelnut are most commonly implicated because of birch sensitisation while in Japan, reactions to apple and peach are more common because of prevalence of alder sensitisation.^{2,8,13,24,25} Pollen trap analysis from different locations within the Sydney area found 82% of trapped pollen grains were tree pollen, 13% grass pollen and 5% weed pollen.²⁶ However, a study of an atopic adult population from Western Sydney reported 67% of patients sensitised to grass pollen, 30–40% to weed and 20% to tree pollen.²⁷

Grass pollen sensitisation is associated with OAS induced by melons (including watermelon), tomatoes, oranges, kiwifruit and peanut.^{5,20} In our study, every child diagnosed with PFS was sensitised to perennial rye, with all children also sensitised to at least one other type of grass pollen. Although not every child with PFS was tested for sensitisation to profilin, two

patients reported symptoms to a wide variety of tropical fruits typically associated with its cross-reactivity profile. Profilin, a panallergen and actin-binding protein found in grasses, trees and weeds, is associated with numerous cross-reactive patterns including watermelon, melon, tomato, banana, pineapple and orange.^{2,5,28} In our population, solely tropical fruits were implicated in inducing PFS. As expected, this significantly differs from other published studies and is explained by the different prevalence and profile of aeroallergens found in the Sydney region.

No standardised treatment for OAS induced by either PFS or FA currently exists. Food avoidance, the standard for management of FA,^{20,22,29,30} is the most commonly adopted practice in the management of OAS.²⁹ This may benefit those individuals with isolated OAS induced by foods with more stable proteins such as peanut and OAS associated with systemic or anaphylactic symptoms. For individuals manifesting OAS without systemic symptoms, strict food avoidance may not be required, as the comparatively milder localised symptoms are reduced or absent when the food is cooked, denaturing the offending protein. There is consensus within the literature for prescription of injectable adrenaline for OAS associated with systemic or anaphylactic reactions.^{1,2}

Reports discussing the role of specific immunotherapy in the management of PFS are conflicting,^{1,2,29} with some reporting improvement in symptoms³¹ and some reporting no apparent improvement in symptoms.³² Therefore, it is unclear whether pollen immunotherapy (either subcutaneous or sublingual immunotherapy) produces any significant or lasting reduction in the symptoms of PFS.

The ability to use frozen fruit in SPTs would provide a convenient way to test patients for sensitisation to fruits out of season. Watermelon (our main sensitiser), pineapple and rockmelon were found to produce results consistent with the fresh fruit samples. However, the remaining fruits tested failed to reliably produce a positive result when compared with a positive fresh fruit result. Importantly, frozen fruits never produced a positive result in the absence of a positive fresh fruit result.

These findings are inconsistent with a recent study that reported statistically significant concordance between fresh and frozen fruit SPT results.^{18,19} Our results suggest that freezing may alter or decrease the allergenicity of these fruits. Alternatively, it may suggest the allergenicity of different proteins, in response to temperature variations and other environmental factors, may vary between foods. The small sample size of those with PFS did not allow statistical analysis so this requires further study including research into the clinical and biochemical effects of freezing on the allergenicity of different fruit and vegetable proteins.

This study has a number of limitations including prevalence determinations from a population with more significant and severe atopic disease than is likely found in the general paediatric population. Furthermore, because of the regional differences in pollen distribution, the prevalence and implicated foods may vary between geographical regions. Further research into the regional variations in the prevalence of OAS and PFS is required in both adult and paediatric populations in Australia.

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