

Pollen Food Syndrome (PFS): A common food allergy in children and adults with increasing prevalence

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Key points:

- PFS is a common food allergy in school age children and adults with onset occurring after sensitisation to pollen.
- Prevalence is increasing alongside rising cases and severity of seasonal allergic rhinitis (SAR) and, in the UK, is particularly associated with birch pollen allergy.
- PFS presents with immediate reactions to raw/uncooked plant foods that contain proteins similar to pollen allergens. Important exceptions are soya and nuts which may still elicit reactions after processing/cooking.
- Most cases of PFS are mild and can be diagnosed and managed in primary care without the need for allergy testing.
- A small proportion of cases present with severe or unusual symptoms and require specialist input and further investigation.
- Conditions that might present with similar symptoms to PFS and should be excluded when making a diagnosis are latex fruit syndrome, Lipid Transfer Protein (nsLTP) allergy and primary food allergies to plant foods such as nuts and kiwi.
- PFS can cause anxiety and unnecessary food eliminations. Referral to a qualified dietitian should be considered.
- Psychological needs of people affected by PFS and SAR needs to be considered.
- The British Society for Allergy & Clinical Immunology (BSACI) have published UK-specific guidelines for the diagnosis and management of PFS and a leaflet for GPs with advice on diagnosis and management.

Introduction

PFS - also known as Pollen Food Allergy Syndrome (PFAS) and Oral Allergy Syndrome (OAS) - is a common type of food allergy that affects children and adults and is becoming increasingly prevalent in the UK¹. It is an IgE-mediated allergy that occurs due to cross-reactivity of certain unstable plant proteins with pollen allergens due to similarity in protein structure. Reactions occur due to the ability of the plant proteins to bind to IgE antibodies developed in response to pollen. In contrast, primary food allergy involves food-specific IgE antibodies².

PFS is characterised by immediate reactions to typically raw/uncooked fruit, vegetables, spices, herbs, seeds, legumes and nuts in people who are either allergic to pollen or sensitised to pollen. Symptoms present immediately or within minutes of eating the food, are usually mild and typically involve the oropharynx. However, systemic reactions and anaphylaxis can occur. Because the plant allergens involved denature quickly when exposed to heat or acid (such as during cooking and digestion), raw/uncooked foods are most typically involved. However, moderately processed soya and roasted nuts can also elicit PFS and, in larger amounts, may induce more serious reactions¹.

Terminology

PFS was historically known as OAS. PFS or PFAS have been proposed as more specific terms to describe the cross-reactive allergy that occurs to unstable food proteins structurally similar to pollen³⁻⁴. There are two main reasons for this: 1) the term OAS is used to describe any oral manifestations of IgE-mediated allergy, including symptoms involved in primary allergy to specific food allergens⁵⁻⁶, and 2) although oral symptoms are common in PFS, the symptoms are not confined to the oral region and, in rare cases, systemic symptoms without oral involvement may be seen⁷.

Prevalence

Overall prevalence of PFS in the adult UK population has been determined to be approximately 2%, or 1-4% depending on area⁸. An individual is initially sensitised to pollen before PFS develops, either in childhood or adulthood. PFS occurs at younger ages and is more common in children than previously recognised⁹. A small study at a London tertiary hospital showed that SAR occurred in children from one year of age and PFS from 4.5 years¹⁰.

The prevalence and the type of pollen and foods involved varies between geographical regions depending on the most common pollen allergens in the area¹. Inhalant allergy to grass and silver birch tree pollen are the most common causes of SAR in the UK, with silver birch pollen most commonly being linked to PFS. Studies have revealed 66% of birch-allergic adults⁸ and 48% of birch-allergic children¹⁰ have PFS. BSACI guidelines for the diagnosis and management of pollen food syndrome in the UK focuses predominantly on birch-sensitised individuals¹. Sensitisation to weed pollens such as mugwort can also elicit PFS, and people who are sensitised to several pollen types may react to a wider range of food. Symptoms of SAR tend to occur in spring (March to May) for individuals with birch pollen allergy, summer (June to August) for those with grass pollen allergy and later summer for those with mugwort pollen allergy¹¹.

The prevalence and severity of pollen allergy is increasing, leading to concomitant increase in PFS. The birch pollen season is lengthening due to rising temperatures associated with climate change¹². Air pollution has been shown to increase the concentration of a key birch tree pollen allergen, Bet v1, associated with PFS¹³ and reduced air quality in urban areas, particularly increased levels of ozone, has been associated with increased severity of SAR independently of the concentration of allergens¹⁴. Birch trees are increasingly being planted to improve air quality in urban areas which may also be driving increase in prevalence.

In the UK, it has been estimated that 26% of adults and 10–15% of children suffer from allergic rhinitis¹⁵. SAR may often go undiagnosed as people self-treat using over-the-counter medications¹⁶ and research suggests that approximately 49% of adults report suffering from symptoms of SAR¹⁷. Other co-

morbidities associated with PFS are asthma, atopic eczema, irritable bowel syndrome and eosinophilic oesophagitis¹. Individuals who are more highly atopic, with associated higher levels of total and specific IgE levels, are more likely to develop PFS¹⁸.

Symptoms

Symptoms are usually mild and involve the mouth, lips, throat and, in some cases, the ears. They tend to occur immediately or within 5–15 min of eating and typically resolve quickly¹, but longer lasting symptoms have been reported¹⁹. Less common reactions include sneezing, runny eyes, peri-oral rash, abdominal pain, nausea, vomiting, mouth ulcerations, swelling of the tongue or throat, cough and breathing difficulties. People with PFS may experience symptoms (such as itchy hands, sneezing and eye irritation) when peeling potatoes or other vegetables¹. Skin symptoms of itch and rash are more common in children, but adults with existing eczema can also find that PFS exacerbates their eczema¹. Oral medicine practitioners have also linked painful mouth and gums, mouth blistering and ulcerations to PFS¹⁹. See table 1 for a list of symptoms and suggested treatment.

In the majority of cases, the allergens are quickly denatured by digestion which limits the extent of the allergic response⁵ and antihistamine treatment is sufficient, or medication may not be needed¹. However, systemic reactions do occur and an estimated 1.7% of reactions cause anaphylactic shock²⁰. More severe cases may require the affected person to carry adrenaline auto-injectors, but this is rare¹. There is increasing concern about systemic reactions linked to increasing severity of pollen allergy and changes in diet, including more widespread

TABLE 1. Symptoms of PFS listed according to severity and proposed treatment (adapted from Oxford University Hospitals NHS, 2014²²)

	Presenting symptoms	Treatment
Mild or moderate	<p>Common symptoms:</p> <ul style="list-style-type: none"> Unusual sensations in the mouth, lips, tongue or throat such as tingling, itching, burning, and/or swelling Itchy nose Itchy, watery eyes Itchy ears <p>Less common symptoms:</p> <ul style="list-style-type: none"> Swelling/angio-oedema of the face Abdominal pain Nausea and vomiting Exacerbation of eczema Itchy hands/sneezing/eye irritation when peeling potatoes or root vegetables Mouth ulcers 	<ul style="list-style-type: none"> Remove the offending food and rinse the mouth (or hands, if affected) with water Monitor symptoms If necessary (e.g. if symptoms persist), treat with appropriate allergy-relieving medication such as antihistamines Advice and guidance about prevention should be provided by health professionals in primary care and a referral to a qualified dietitian considered
Severe	<p>Rare symptoms:</p> <p>Airway</p> <ul style="list-style-type: none"> Swollen tongue Difficulty swallowing Throat tightness Change in voice (hoarse/croaky) <p>Breathing</p> <ul style="list-style-type: none"> Difficulty breathing Chest tightness Noisy breathing Persistent cough Wheeze <p>Circulation</p> <ul style="list-style-type: none"> Feeling dizzy or faint Collapse Loss of consciousness Pale and floppy (in babies/small children) 	<ul style="list-style-type: none"> If adrenaline auto-injector is prescribed*, this should be administered without delay Ring 999 and seek emergency assistance Lie flat with legs raised unless breathing is affected in which case sitting may better aid breathing The affected person should not stand, walk or move around Monitor symptoms. If there is no improvement after five minutes of the first dose of adrenaline, a second adrenaline auto-injector should be administered in the other leg Hospital attendance and referral to specialist allergy service is required <p>*Self-administered adrenaline auto-injectors are rarely needed for PFS but have been included for completeness.</p>

adoption of plant-based foods including soy/nut milks, soya in protein shakes and nutritional products, and increased intake of fruits, vegetables and juices/smoothies²¹. Bariatric surgery and conditions and medications that reduce stomach acid may also increase risk of systemic reactions¹.

Foods involved

The foods involved in reactions vary between individuals and depends on which pollen they are sensitised to. See table 2 for foods known to cross-react with different pollens. Typical food triggers in the UK cross-react with birch and are¹:

- Apple, carrot, celery, kiwi, pear, stone fruits, strawberry and tomato in raw forms
- Soya milk
- Raw almonds, hazelnuts and walnuts
- Raw peanuts (e.g. red-skinned peanuts, unroasted monkey nuts)

It is a characteristic of PFS that reactions usually only occur to raw/uncooked forms of the food (freezing does not appear to significantly alter the allergens and therefore frozen versions of raw fruit and vegetables have potential for eliciting a reaction²³). However, relevant allergens in soya and nuts may resist degradation during heating and still cause reactions when processed/cooked e.g. soya milk, soya protein in nutritional

shakes and roasted nuts²⁴⁻²⁶. In some cases, very lightly cooked fruit/vegetables (e.g. after quick stir-frying or steaming) can elicit reactions if the cooking has been inadequate to denature the PFS-associated allergens¹.

Pasteurised juices, cooked, tinned/canned and processed forms of fruit and vegetables are usually well-tolerated. Peeled and de-seeded fruit and vegetables, even in raw form, may be tolerated as allergens are mainly contained in the peel and pips. The allergen in apple associated with PFS is low at harvesting and increases during storage, therefore eating seasonally can be helpful¹. Different varieties of fruits may be better tolerated than others and for patients with mild reactions, exploration of this can be recommended. Golden Delicious, Granny Smith, Starking, Cox's Orange Pippin apple varieties and organic apples have been shown to have increased levels of PFS-associated allergen and are more likely to cause reactions than other apple varieties²⁷⁻³².

Systemic and severe reactions have been associated with larger intakes of allergens in a short space of time such as freshly prepared fruit/vegetable juices or smoothies, soya milk, raw nuts, concentrated nut products and larger amounts of roasted nuts¹. When ingested quickly, liquids such as soya milk have the effect of diluting the stomach acid, reducing the acid-denaturing effect on proteins²⁶. Jackfruit has also been linked with more severe PFS reactions³³.

TABLE 2. Foods that exhibit cross-reactivity with various pollens (adapted from Skypala et al, 2022¹)

Pollen	Fruits	Vegetables	Legumes	Tree nuts	Seeds	Herbs and spices	Other
Timothy Grass	Peach, melon, watermelon, orange, tomato, kiwi	Aubergine, bell pepper, chilli, potato, swiss chard	Peanut			Cayenne pepper	Wheat, barley, rye
Silver Birch (causes most of the cases of PFS in the UK)	Apple, apricot, cherry, jackfruit, pear, peach, nectarine, plum, damson, greengage, kiwi, fig, strawberry	Carrot, celery, tomato	Beansprouts, peanut, mangetout, soya (includes edamame beans)	Almond, brazil nut, hazelnut, pecan, walnut	Poppy seeds	Coriander, parsley	
Mugwort	Apple, banana, melons, peach	Bell pepper, broccoli, cabbage, carrot, celery, celeriac, courgette, parsnip, potato, fennel, garlic, onion		Hazelnut	Sunflower seeds, mustard	Aniseed, angelica, chervil, coriander, cumin, dill, fennel, parsley, rosemary	Honey
Ragweed	Watermelon, melon, banana	Squash, pumpkin, courgette, cucumber, marrow					

Diagnosis and Management

PFS can usually be diagnosed and managed in primary care. The BSACI has produced a leaflet for GPs in the UK that includes a useful algorithm to support this (see figure 1). Diagnosis can be made via a thorough clinical history that includes details about reported symptoms, food triggers and history of SAR. If the symptom history and food triggers are consistent with PFS, diagnosis can be made without need for allergy testing or onward referral. Allergy testing and referral to specialist allergy services is required when there is possibility of a primary food allergy (e.g. reactions to cooked tree nuts and/or peanuts), more severe symptoms are reported, the symptoms are systemic and not confined to the oropharynx, the food triggers have been cooked/processed fruits and vegetables, and when young children present with reactions to fruit, especially kiwi, banana and melon^{1,34}. Referral to secondary care may also be required when multiple foods are avoided and there is a high level of anxiety.

The BSACI guideline for the diagnosis and management of pollen food syndrome in the UK¹ advises that “if the answer to [all] of the following [five] questions is affirmative, then the diagnosis is almost certainly PFS”:

1. Are the foods provoking symptoms raw fruits, raw nuts or raw carrot/celery?
2. Are the same trigger foods tolerated when well-cooked or roasted?
3. Do the symptoms occur immediately or within a few minutes of eating?
4. Are the symptoms localised to the oropharynx and include tingling, itching or swelling?
5. Does the patient experience seasonal allergic rhinitis, or if not, are they sensitised to pollen?

Practitioners should be mindful that atypical, systemic or severe symptoms could be indicative of a primary food allergy, e.g. to peanuts, tree nuts, kiwi, or allergy to nsLTPs. Primary food allergies to specific foods generally result in reproducible symptoms to every exposure of the food and are often independent of whether the food is raw or cooked, although symptom severity can vary from mild (potentially involving only oral symptoms) to severe and life-threatening reactions. nsLTPs are a ubiquitous family of proteins found widely in plant foods and are resistant to heat and digestion³⁵. People with nsLTP allergy can experience reactions to numerous plant

foods, but they tend to be more unpredictable than primary allergy as reactions may only occur with co-existing factors (exercise, alcohol, fasting, menstrual cycle or non-steroidal anti-inflammatory drugs)³⁵.

Latex fruit syndrome may present in a similar manner to PFS and is due to sensitisation to latex allergen(s) with cross-reactivity to plant food proteins. 30-50% of patients with latex allergy are known to react to foods in this way, mainly banana, avocado, chestnut, and kiwi fruit³⁶. Latex cross-reactive reactions to potato, tomato, bell pepper, cassava and curry spice have also been reported³⁷. Reactions can be severe in patients with established latex allergy; milder reactions have also been reported in people who are sensitised but asymptomatic to latex¹.

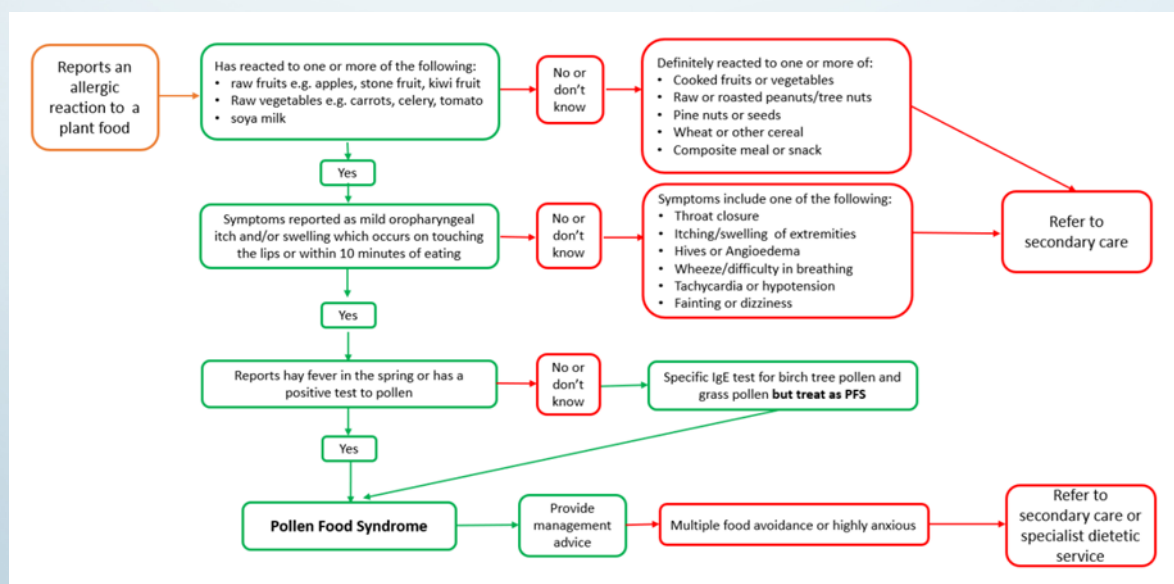
For straight-forward cases of PFS, BSACI³⁴ recommends that GPs take the following steps after diagnosis is made:

- Advise the patient to avoid only those raw [or minimally cooked] foods which have already provoked symptoms
- Provide the patient with an information leaflet on PFS
- Refer the patient to a community dietitian if many fruits or vegetables trigger reactions, or the diet is already compromised due to other dietary restrictions
- Treat co-morbidities such as rhinitis, asthma and eczema optimally

The BSACI guidelines¹ further recommend addressing the psychological needs of people with PFS and referral to a qualified dietitian for individualised dietary advice. Multiple food avoidances and fear of allergic reactions in is known to affect health-related quality of life in people with PFS³⁸. This comes on top of the burden of SAR-related symptoms impacting on sleep, mood, performance and daily life. Individualised dietary advice is helpful for reducing anxiety and improving quality of life¹. It has also been recommended that all individuals with PFS should receive instruction on how to reduce the risk of severe reactions by exercising caution with concentrated or unusual forms of plant foods (including soya/nut milk, plant-based nutritional supplements, and fresh juices and smoothies)²¹.

Allergy UK has an information leaflet on PFS available on our website³⁹ which provides practical advice such as trying trigger foods cooked, canned or microwaved, trying different varieties of a fruit e.g. apple or beef tomatoes that can more easily be peeled and de-seeded, when to take antihistamine medication and when to seek further medical attention.

Figure 1. Algorithm for the diagnosis of PFS on the basis of a clinical history (from BSACI, 2022)³⁴



Nutritional considerations

People with PFS typically react to four or more foods¹. Where there is sensitisation to multiple pollens, more foods may be involved. In most cases, and with a good understanding of the condition, the diet can be adapted without negative nutritional consequences. However, anxiety about reactions can lead to unnecessary food eliminations, such as elimination of all pollen cross-reactive plant foods (as per table 2). A qualified dietitian can provide advice on how to manage the food avoidances and ensure that nutritional health is not compromised. Referral for dietetic support is particularly recommended for people with multiple food avoidances, either due to multiple PFS food triggers, concomitant food allergy or intolerance, or religious diets or lifestyle choices such as choosing to follow a mostly or entirely plant-based diet¹.

The BSACI guidelines for the diagnosis and management of pollen food syndrome in the UK¹ includes an excellent table outlining alternative foods that are likely to be tolerated when certain foods are avoided due to PFS (see table 3).

TABLE 3. Dietary management of PFS (from Skypala et al., 2022)¹

Food	Common triggers	May still provoke symptoms	Usually safe to eat
Fruits and vegetables (general)	Raw fruits (type depends on pollen sensitisation), fresh fruit or vegetable smoothies or juices	Peeled or microwaved	Baked, boiled, dried or canned fruits, vegetables and herbs
Fruits (specific)	Apples, apricots, cherries, kiwifruit, melon, peaches, pears, plums	Banana, citrus fruits, mango, watermelon	Blueberries, cranberries, grapes, raspberries
Vegetables (specific)	Carrot, celery, coriander, cucumber. Peeling carrots, parsnips, potatoes, squash	Aubergine, beansprouts, courgette, lettuce, mange tout, potato (jacket), rocket, sugar snap peas	Broccoli, cabbage, canned beans, carrots, cauliflower, garlic, mushrooms, onion, parsnips (peels, boiled or roasted), potatoes (boiled), squash, swede, tomato puree, turnip
Legumes	Edamame beans, monkey nuts, potatoes (raw), potatoes (redskin), soy milk, soy protein powders	Peanuts (roasted), tofu	Beans (cooked or canned, including haricot beans), broad beans, butter beans, chickpeas / black eyed peas, kidney beans, lentils, roasted peanuts in savoury and sweet dishes and chocolate foods that are labelled as 'may contain peanuts', soy flour, soy lecithin
Tree nuts	Raw almonds, brazil nuts, hazelnuts, pecan nuts, walnuts	Roasted nuts or nuts in sweet or savoury foods	Cashew nut, chestnut, macadamia nut, shea nut and foods that may contain nuts
Seeds		Mustard and mustard seeds, pumpkin seeds, sunflower seeds	Linseeds/flaxseeds, pine nuts, poppy seeds, sesame seeds, tahini
Miscellaneous	Products containing or made with bee pollen - may contain pollen allergens	Honey	Chocolate, confectionary, jam, marmalade, sugar, syrups including maple syrup

Conclusion

PFS is a common food allergy in the UK with increasing prevalence alongside rising cases and severity of SAR. It can manifest at any age and needs to be considered when children and adults present with reactions to raw/uncooked plant foods, soya-based drinks and nuts. Most cases are mild and can be diagnosed and managed effectively in primary care. However, systemic reactions and severe symptoms, including anaphylaxis, do occur and practitioners need to be mindful of when referral to specialist services is required for further allergy testing and support. Referral to a qualified dietitian is useful to help patients better understand and manage the condition whilst optimising nutritional health and is especially important when diets are more highly restricted.

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