

REVIEW ARTICLE

Practical approach to nutrition and dietary intervention in pediatric food allergy

Marion Groetch & Anna Nowak-Wegrzyn

Jaffe Food Allergy Institute, Pediatric Allergy & Immunology, Mount Sinai School of Medicine, New York, NY, USA

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Correspondence

Marion Groetch, Mount Sinai School of Medicine, 1 Gustav L. Levy Place, Box 1198, New York, NY 10029, USA
Tel.: 212-241-5548
Fax: 212-426-1902
E-mail: marion.groetch@mssm.edu

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Although the need for nutritional and dietary intervention is a common thread in food allergy management, the type of food allergic disorder and the identified food allergen will influence the approach to dietary intervention. A comprehensive nutrition assessment with appropriate intervention is warranted in all children with food allergies to meet nutrient needs and optimize growth. However, dietary elimination in food allergy may also have undesirable consequences. Frequently, an elimination diet is absolutely necessary to prevent potentially life-threatening food allergic reactions. Allergen elimination can also ease chronic symptoms, such as atopic dermatitis, when a food is proven to trigger symptoms. However, removing a food with proven sensitivity to treat chronic symptoms may increase the risk of an acute reaction upon reintroduction or accidental ingestion after long-term avoidance, so it is not without risk. Additionally, it is not recommended to avoid foods in an attempt to control chronic symptoms such as AD and EoE when allergy to the specific food has not been demonstrated. Ultimately, allergen elimination goals are to prevent acute and chronic food allergic reactions in the least restrictive, but also the safest environment to supply a balanced diet that promotes health and growth and development in children.

The rising tide of food allergies is well described in the scientific literature (1, 2). Although food allergies can present with symptoms that may be mild or severe, chronic or acute, impact the skin, gastrointestinal, respiratory, or multiple organ systems, the one constant is that food allergies are managed through dietary intervention. The World Allergy Organization (WAO), the United States National Institute of Allergy and Infectious Disease (NIAID), and the United Kingdom's National Institute for Health and Clinical Excellence have issued guidelines for the diagnosis and management of food allergy; each independently recommending nutrition therapy or consultation with a dietitian (1, 3, 4). Dietary assessment and guidance are involved in each step of the diagnosis and management of food allergy from early nutritional interventions to determine whether a particular food is antigenic to ongoing long-term treatment of the diagnosed condition. Appropriate dietary assessment and intervention are integral to successful management of all types of food allergic disorders.

Avoidance of the offending food-chasing the moving target

Although numerous therapeutic treatment options are currently being investigated, dietary avoidance remains the

primary treatment in food allergy management (5). Elimination of a food or food group in the pediatric diet is not without nutritional risk; therefore, it is important that an elimination diet is prescribed only for the treatment of a diagnosed food allergy or for diagnostic purposes for a limited period of time. Thus, professional food allergy evaluation is required. As many food allergies of early childhood resolve over time, regular reassessment by the allergist is also important to avoid extended, unnecessary elimination diets.

Even under the best circumstances, avoidance of allergens is not simple [see Box 1 Clinical vignette: Pitfalls with label reading]. The variety of commercial food items available is ever expanding. Ingredients in commercial products also change frequently, requiring consumers to read product labels each and every time an item is purchased. Laws that guide the labelling of food allergens vary from country to country (6). These laws begin by identifying those foods that are considered the 'common food allergens' or 'major allergens' requiring full disclosure on product labels. Be aware that some countries do not yet have specific food allergen labelling laws. Healthcare practitioners and consumers should be aware of their country's food allergen labelling laws. When travelling abroad, consumers with food allergies should always check the food allergen labelling laws of their destination country prior to purchasing and consuming packaged foods (7) (see Table 1).

Box 1 Clinical vignette: Pitfalls with label reading

A 7-year-old boy with wheat allergy developed severe anaphylaxis with pharyngeal edema (stridor), cough, wheezing, generalized urticaria, and emesis within 45 min of ingesting a small piece of cornbread that was baked at home from a store-bought mix. The inspection of the package revealed that the mix contained wheat flour as 2nd ingredient on the list. The boy's father recalled reading labels on two cornbread mixes in the store: one that was wheat-free and one that contained wheat. He thought he purchased the wheat-free cornbread mix.

Key message: Label reading is challenging and mistakes are common. The ingredients may change at any time and constant vigilance is imperative. Reading product labels once at the point of purchase and then again prior to ingestion will help patients catch errors in label reading before a reaction occurs.

Box 2 Clinical vignette: Baked-milk diet

A 5-year-old child with milk allergy passed an oral food challenge under physician supervision to a muffin baked with 1.3 g of milk protein. She added baked milk products to her diet. She has reported several episodes of itchy mouth and abdominal pain with baked products such as cakes and breads. The inspection of the baked products revealed that they were not baked through and were too moist and soggy in the middle. After thorough baking was enforced, the child has had no subsequent complaints.

Key message: Under-baking may result in allergic symptoms.

Precautionary labelling: cross-contact

Although food allergen labelling laws have made identification of allergenic ingredients easier, they still do not address a variety of issues such as the potential presence of allergens due to cross-contact or full disclosure of ingredients that are not considered 'major allergens' (6). The potential presence of allergenic ingredients due to cross-contact presents a small but tangible risk of allergen exposure to consumers with food allergies. Manufacturers may voluntarily add a precautionary label such as 'may contain milk,' or 'manufactured in a facility that manufactures milk products,' but these labels are not

mandatory and they are unregulated, leaving consumers feeling uncertain about the safety of manufactured products (8). NIAID food allergy guidelines suggest consumers avoid products with precautionary labels for their allergens (1). In the United States, Pieretti and colleagues evaluated over 20,000 manufactured products obtained from 99 various supermarket stores and found that overall 17% of manufactured foods in their large sample carried a precautionary label (9). In Australia and the European Union, the percentage of products carrying precautionary statements may be even higher, further limiting those manufactured food products available to consumers with food allergies (10, 11).

Another area of ambiguity in label reading relates to allergens that are not covered under the labelling laws. While the vast majority of allergic reactions occur to 8 foods – milk, egg, wheat, soy, peanut, tree nut, fish, and shellfish – consumers who are allergic to other ingredients may have a more difficult time interpreting product labels. For those allergic to an ingredient not considered a major allergen such as fruit ingredients, or sesame and mustard in the United States where sesame and mustard are not considered allergens, additional precautions are necessary. These ingredients may be hidden in a vague labelling term such as 'natural flavoring' or 'spice.' These vague ingredient terms will alert the consumer with allergies that they should either avoid the product or call the manufacturer to determine whether their specific allergen is an ingredient in the product. Of course, common sense must prevail. A peach-flavored lollipop is not likely to contain a mustard flavoring and a prepared salad dressing is less likely to contain a peach-based flavoring or seasoning. Consumers with food allergies are confronted with these and other challenges on a daily basis.

Changing paradigms of managing milk and egg allergy: shades of gray

Furthermore, there are nuances to avoidance. While treatment typically requires strict allergen elimination, we now know that as many as 70 percent of patients with milk or egg allergy may tolerate extensively baked milk or egg ingredients (12–15). Heating milk and egg ingredients generally decreases protein allergenicity by destroying conformational epitopes (12, 13, 16). The introduction of extensively heated milk and egg protein in the diet of those with milk and egg allergy, who tolerate the baked form, appears to represent an alternative approach to oral immunomodulation (12, 13, 17–19). Researchers at Mount Sinai School of Medicine in New York introduced baked milk into the diets of children who were baked milk tolerant yet reactive to unheated milk. Children who incorporated baked milk into the diet were 16 times more likely to become tolerant to unheated milk compared with a comparison group of children who continued strict avoidance of milk ingredients (12). Children who incorporated baked egg into the diet were 14.6 times more likely than children in the comparison group ($p < .0001$) to develop regular egg tolerance, and they developed tolerance earlier (median 50.0 vs. 78.7 months; $p < .0001$) (18). Children participating in these studies were monitored closely and

Table 1 Major food allergens based on country specific labeling laws

Country or Countries	EU	USA, Mexico, Hong Kong, China	Australia and New Zealand	Canada	Japan	Korea
Identified allergens	Milk	Milk	Milk	Milk	Milk	Milk
requiring full	Egg	Egg	Egg	Egg	Egg	Egg
disclosure on	Soy	Soy	Soy	Soy	Wheat	Wheat
product labels	Gluten-containing grains	Wheat	Wheat	Wheat	Buckwheat	Buckwheat
	Peanut	Peanut	Peanut	Peanut	Peanut	Soy
	Tree nuts	Tree nut	Tree nut	Tree nut	Shrimp	Peanut
	Fish	Fish	Fish	Fish	Crab	Mackerel
	Shellfish-Crustacean & Mollusks	Shellfish-Crustacean	Shellfish-Crustacean Sesame	Shellfish-Crustacean & Mollusks		Crab
						Shrimp
						Pork
						Peach
						Tomato
	Mustard			Sesame		
	Celery					
	Lupine					
	Sesame					

no adverse effects of baked egg and milk diet were reported on growth, intestinal permeability and chronic allergic conditions such as atopic dermatitis, asthma, and allergic rhinitis. No child developed eosinophilic gastroenteropathy. However, in patient populations at large, the adherence to the principles of the baked milk/egg diet may be less stringent and ongoing monitoring is necessary and dietary counseling paramount [see Box 2 Clinical vignette: Baked milk diet]. Therefore, physicians, dietitians, nurses, and other healthcare providers must understand how to provide appropriate guidance on incorporating these ingredients. For instance, it is not always obvious from a product label how an ingredient was processed. A frosted cookie or cake may contain baked milk in the cake and unbaked milk in the frosting. A flavored cracker may have a baked milk ingredient or it may have a milk ingredient in the flavoring that is topically applied (sprayed on) after the cracker is baked. So while introducing baked milk or baked egg ingredients into the diet may greatly improve the quality and diversity of the diet, it also introduces additional nuances to avoidance that must be conveyed to the consumer with allergies. In such situations, dietary education is necessary. Table 2 provides examples of appropriate foods to include for a patient who has passed a basic baked milk or baked egg challenge. A physician may choose to advise the family to add additional baked milk or egg items or may even limit some of these items or serving sizes of these items based on the patient's clinical history. Oral immunotherapy to additional food proteins such as peanut and wheat are currently being investigated but are not yet ready for clinical practice (20).

The effects of allergen avoidance on nutrition in children

Comprehensive dietary education should include not only how to avoid specific allergens, but also guidance on how to

appropriately substitute for the nutrients typically provided by the eliminated food(s). Inadequate energy intake in children with food allergy on elimination diets has been demonstrated in numerous studies (21, 22). However, children with food allergies may also have different growth patterns than children without food allergies even when nutrient intake is similar. Flammarion and colleagues assessed nutritional status, growth, and dietary intakes of children with food allergies who were counseled by a dietitian and found that children with food allergies were smaller for their age than controls even when they received comparable nutrient intakes. The reason for altered growth status in this study was unclear (23). The authors proposed altered growth status may be due to potential loss of nutrients caused by continued allergic inflammation and/or abnormal intestinal permeability caused by non-compliance with the diet, additional undiagnosed allergy or antigen remnants in the substitute formula (23). Another proposed explanation was higher protein and energy needs of children with moderate to severe atopic dermatitis. Isolauri et al. did find lower albumin levels in children with cow's milk protein allergy and atopic dermatitis than those found in healthy controls despite similar protein intakes (24). This potential growth difference highlights the need to make every effort to optimize nutrition because suboptimal nutrient intake may exacerbate the risk of lower growth rates in this population.

The pediatric population with food allergies is at nutritional risk also because children are more likely than adults to require avoidance of foods of greater nutritional value, such as milk, and their nutritional needs for growth and development are substantial and unique. The nutrient needs of each child must be determined and a plan devised to meet those needs within the context of the allergen-restricted diet. Although most children with food allergies will eventually outgrow allergy to foods such as milk, egg, and soy, today's child with food allergies appears to acquire tolerance later

Table 2 Guidelines to incorporate baked milk and baked egg in the diet

Types of Foods	Allowed	Not allowed
Baked milk diet	Store-bought baked goods such as rolls, muffins, cupcake, cookies, crackers, and bread, with milk or milk protein ingredients listed as the 3rd ingredient or further down the list of ingredients. Home-baked goods (such as rolls, muffins, cupcakes, or cookies) that have 240 ml milk per batch of a recipe (yield 6 servings per batch or approximately 40 ml baked milk per serving). Home-baked items with center that is thoroughly cooked through (not moist or soft). Products should be baked in individual serving size: cupcake, not cake; brownie muffins, not brownies; rolls, not bread. Baked milk containing baked goods with milk-free chocolate chips. Remember to check store-bought products and ingredients based on the patient's other food allergies to avoid a reaction to other allergens. Servings are specified in the nutritional information section of the food label or determined by the yield of the recipe	Store-bought baked goods such as rolls, muffins, cupcake, cookies, crackers, and bread, with milk or milk protein ingredients listed as the first or second ingredient. Home-baked goods with more than 40 ml baked milk per serving. Full-sized home-baked products such as cakes, brownies, and breads (commercial breads are safe) that may not be fully cooked in the middle. Baked milk containing baked goods with milk chocolate chips. Continue to avoid milk products which are not fully baked such as milk-based frostings, icings, and milk-containing flavorings that are topically applied after the product is baked.
Baked egg diet	Store-bought baked products with egg listed as the 3rd ingredient or further down the list of ingredients. Home-baked products that have no more than 2 eggs per batch of a recipe (yield 6 servings) or 1/3 of a large egg. Home-baked items with center that is thoroughly cooked through (not moist or soft). Products should be baked in individual serving size: cupcake, not cake; brownie muffins, not brownies; rolls, not bread. Remember to check store-bought products and ingredients based on your child's food allergies to avoid a reaction to other allergens.	Store-bought baked products with egg listed as the 1st or 2nd Home-baked products that have more than 2 eggs per batch of a recipe (yield 6 servings) or 1/3 of a large egg. Full-sized home-baked products such as cakes, brownies, and breads (commercial breads are safe) that may not be fully cooked in the middle Continue to avoid: - Caesar salad dressing - Custard - Eggs in form of hard boiled, scrambled or poached, etc. - French toast - Frosting - Ice cream - Mayonnaise - Quiche

Developed at the Jaffe Food Allergy Institute, Mount Sinai School of Medicine, New York, NY.

than previously described; potentially magnifying the nutritional as well as medical, social, financial, and psychological burden of the food allergy (2, 25, 26). Children on elimination diets will have the potential for some degree of nutritional risk and the NIAID food allergy guidelines recommends nutrition therapy for all children with food allergy (1).

Cow's milk allergy

Certain foods when avoided are more likely to result in increased nutritional risk due to their nutrient contribution to the pediatric diet. For instance, cow's milk is a nutrient dense food and inadequate nutrient intake and decreased growth are more likely to occur in children who are allergic to cow's milk (21, 22). Cow's milk and cow's milk products are a major

source not only of calcium, riboflavin, phosphorus, pantothenic acid, vitamin B12 and vitamin D (in those countries with vitamin D-fortified milk), but also protein and fat. When milk is eliminated from the diet, alternative sources of these nutrients must be found elsewhere in the diet (see Table 3).

Worldwide, breast-feeding is considered the optimal source of infant nutrition and infants with food allergies are no exception. Exclusive breast-feeding is recommended for infants up to 6 months of age at which time complementary foods should be introduced. The infant with cow's milk allergy may benefit from a maternal cow's milk elimination diet. The World Health Organization's Diagnosis and Rationale for Action against Cow's Milk Allergy (DRACMA) guidelines recommend continuing either breast-feeding (with maternal milk avoidance) or a substitute formula for all infants and toddlers up to 2 yr of age with milk allergy (3). DRACMA provides

Table 3 Alternative sources for nutrients in cow's milk

Nutrient	Alternative dietary sources
Calcium	Fortified alternative beverages (soy, rice, oat, almond, coconut, hemp, potato), calcium fortified tofu, calcium fortified juice
Vitamin D*	Fortified alternative beverages, fortified margarine, fortified alternative yogurts, fish oils, salmon, and other fatty fish
Vitamin B12	Meat, fish, poultry, eggs, enriched alternative 'milk' beverages
Vitamin A	Liver, egg yolk, fortified margarine, dark green leafy vegetables, deep orange fruits and vegetables, fortified alternative beverages
Pantothenic acid	Meat, vegetables, eggs, whole grains, legumes, fish
Riboflavin	Dark green leafy vegetables, enriched, and whole-grain products
Protein	Meat, fish, poultry, eggs, soy products, peanut, other legumes, tree nuts, and seeds
Fat	Vegetable oils, margarine, avocado, meats, fish, poultry, peanut, tree nuts, seeds

Note that fortified alternative beverages are not appropriate for infants and may not be safe and appropriate as a substitute for fluid milk for toddlers and young children. Please consider overall nutrient intake and potential risks. (27)

*In countries where milk is fortified. Read labels for alternative 'milk' products for degree of fortification.

Table 4 Substitute formula recommendations for infants and toddlers with cow's milk allergy as per DRACMA guidelines*

Food allergic disorder	First formula recommendation	Second formula recommendation	Third formula recommendation
Low risk of anaphylaxis	eHF-C	AAF	Soy
High risk of anaphylaxis	AAF	eHF-C	Soy
Non-IgE (FPIES or Proctocolitis)	eHF-C	AAF	—
Eosinophilic esophagitis	AAF	—	—

Key:

DRACMA: Guidelines for the diagnosis and rationale against cow's milk allergy.

eHF-C: Hypoallergenic extensively hydrolysed casein based formula.

AAF: Hypoallergenic amino acid based formula.

Soy: Soy-based formula.

*DRACMA guidelines should be interpreted with consideration for patient preference, individual clinical circumstance, and cost.

guidance on choosing substitute formulas based on the type of food allergic disorder, and these recommendations can be found in Table 4. After 2 yr of age, with a diverse diet, calcium supplementation may be all that is required, although a dietary assessment would be prudent to ensure adequate intake of all

essential micro and macronutrients. Parents may need advice regarding dietary choices to ensure adequate energy, protein, and fat intakes. Additional micronutrient supplementation may also be required. Henriksen and colleagues conducted a population-based survey of children (age 31–37 months) on milk-free diets and found they had significantly lower intakes of energy, fat, protein, calcium, riboflavin, and niacin (21). When a milk substitute (either soy formula or hydrolyzed formula) was included in the diet, the nutritional content improved significantly, although calcium and riboflavin intakes remained below recommended levels.

In addition to infant and toddler substitute formulas, fortified alternative beverages are often recommended as milk substitutes for toddlers and older children. Fortified alternative beverages are not appropriate for infants and may not be safe and appropriate as a substitute for fluid milk for toddlers and young children (27). Please consider overall nutrient intake and potential risks. Fortified soy beverage can be a good substitute, if tolerated, as it contains appropriate protein and adequate fats. Other fortified alternative plant-based beverages such as rice, almond, and potato 'milk', however, are very low in both protein and fat. A family may choose to use these other alternative plant-based beverages for social reasons (use in recipes or mixing with solid foods) but not as a primary drink for nutritional reasons. Young toddlers require 30–40% of their daily energy intake from fat (28, 29). Children on milk avoidance diets must eliminate not only milk and dairy products such as full fat yogurts, butter, and cheeses but also many of the manufactured and processed foods that contain milk as an ingredient that are common in pediatric diets. This leaves a diet that comes predominantly from whole foods, and if dietary fats are not intentionally added, the resulting diet may be too low in fat, essential fatty acids, and energy. The addition of milk-free margarine or vegetable oils (olive, canola, soy, corn, safflower, etc.) to appropriate foods can be an easy solution, so assessing dietary fat intake and adding sufficient oil to meet fat, essential fatty acid and energy needs are prudent and practical suggestions. Adequate protein is another area of concern on a pediatric milk elimination diet. Meat, fish, poultry, eggs, nuts, legumes, and seeds are additional sources of protein in the diet, but young toddlers do not always prefer or are not always efficient at eating meats and poultry, and many families continue to avoid other high-protein food sources (fish, nuts, seeds) due to concerns about allergic risk. Protein intake in children should comprise 10–30% of daily energy intakes (5–20% in infants) (28). Protein intake can be improved when necessary by incorporating a variety of small amounts of protein-rich foods in each meal and snack. The allergist can also assist by providing specific guidance to families as to when other potentially allergenic foods can be introduced.

Grains

Grain allergies, most commonly wheat allergy, present nutritional challenges too. Whole and enriched grains provide an excellent source of complex carbohydrates, thiamin, niacin, riboflavin, and iron. Additionally, whole grains provide dietary fiber, magnesium, and vitamin B6. In the United States, many grains are now enriched with folic acid. Wheat is the most

common grain used in western diets, and it is also the most common grain allergy, with major allergens contained in the gluten fraction. In addition to wheat, gluten is found in rye, barley, spelt, and their hybridized varieties. When wheat is eliminated, nutrient dense alternative grains should be provided to substitute for the nutrients normally provided by wheat in the diet (see Table 5 for suggestions). There is increasingly greater variety of alternative gluten-free ready-made products and flours available worldwide. As gluten-free products are also wheat-free, they may be useful on a wheat elimination diet when other wheat-free grains are tolerated. Use of these products will help patients meet energy and carbohydrate needs. As with a diet that does not eliminate wheat, choosing whole-(alternative)grain products will help to provide adequate sources of fiber, iron, and B vitamins. Patients without access to (rural communities) or limited resources for purchasing alternative grains (which tend to be more costly) may be at greater risk of poor substitution. This population may benefit from advice and resources for online ordering or educating families to prepare wheat or gluten-free meals and snacks from 'scratch,' which can be less cost prohibitive.

Soy, egg, peanut, tree nut, fish, and shellfish allergies

Although these other commonly allergenic foods in children are all nutrient dense, they typically do not supply a large percentage of daily energy intakes and the nutrients in these foods can be provided by other foods in a diverse diet without

difficulty. Allergy to any of these foods with other dietary constraints however, such as a vegetarian diet, a picky or faddy eater or a diet restricted for religious reasons may make meeting nutritional needs more challenging. Additionally, a multiple food elimination diet including any of these major allergens may present greater challenges to meeting nutrient needs.

Nutritional impact of food allergic disorders

Food protein-induced proctocolitis

In addition to the type of food avoided, the type of food allergic disorder may influence the potential for nutritional risk. For instance, food protein-induced proctocolitis typically begins in early infancy in response to milk or soy proteins either in the breast milk or infant formula. Symptoms of blood and mucous in the stools and possibly diarrhea appear benign without accompanying growth delay or overt nutritional risk. These symptoms typically resolve within 48–72 h after removal of the suspected antigen (30). Although this food allergic disorder requires elimination of milk (and possibly soy), the nutritional risk remains minimal because tolerance is typically acquired by 1 yr of age and nutritional substitution in infancy is easily achieved. Infants can continue breast-feeding with maternal dietary elimination of the trigger food(s) or be fed a hypoallergenic formula such as an extensively hydrolyzed casein-based formula (eHF-C) or an amino acid-based formula (AAF) for those who continue to have symptoms on the eHF-C (30) (see Table 4). With maternal elimination of cow's milk, the maternal diet should be evaluated and a safe alternative milk substitute or supplementation of calcium and vitamin D in the maternal diet may be required. With the introduction of complementary solid foods to the infant with proctocolitis, allergen-free (typically milk and/or soy) solid foods should be provided until tolerance is achieved.

Food protein-induced enterocolitis syndrome

Other food allergic disorders present greater nutritional challenges, however. Food protein-induced enterocolitis syndrome (FPIES), especially to multiple foods or solid foods, can result in extremely limited diets [see Box 3 clinical vignette: Feeding refusal]. FPIES is commonly seen prior to 6 months of age and typically resolves by 3 yr of age so children may be affected throughout the toddler years or longer. Children with FPIES exhibit gastrointestinal symptoms that include delayed recurrent vomiting (100%), lethargy (77%), diarrhea (25%), and pallor (14%) (31). FPIES is often associated with milk proteins in infant formulas with a potential risk of concomitant soy protein allergy reported in the United States, although recent research from Israel and Korea did not find a greater associated risk of concomitant soy allergy in these countries (31). FPIES may also occur to solid food proteins and has been reported most commonly to grains such as rice, oats, barley, but also to chicken, turkey, egg white, green pea,

Table 5 Alternative sources for nutrients in wheat

Nutrient	Alternative dietary sources
Niacin	Meat, poultry, tuna, salmon, liver, peanuts, seeds, legumes, enriched- and whole-grain alternative grain products
Thiamin	Liver, pork, other meats, sunflower seeds, enriched- and whole-grain alternative grain products, nuts, and legumes
Riboflavin	Milk, dark green leafy vegetables, enriched- and whole-grain alternative grain products
Iron	Heme iron: Meat, fish, shellfish, poultry Non-heme iron*: Enriched- and whole-grain alternative grain products, legumes, and dried fruits
Folic acid	Enriched- and whole-grain alternative grain products**, beef liver, spinach, legumes (especially lentils), avocado, orange juice
Carbohydrates	Fruits, vegetables, legumes and products made with alternative grains or flours such as rice, oat, corn, buckwheat, potato, tapioca, amaranth, millet, quinoa
Fiber	Fruits, vegetables, alternative whole grains

*Non-heme iron sources are better absorbed if consumed with a food that provides vitamin C.

**Read product labels as policies regarding enrichment vary based on country of origin.

peanut, sweet potato, white potato, fruit protein, fish, molluscs, and others (32). Additionally, children with FPIES may not acquire tolerance in infancy and avoidance through the early toddler years or longer may prolong the duration of required avoidance hence increasing nutritional risk (31). It should also be noted that approximately 25–65% of those with FPIES may develop atopic dermatitis, which may exacerbate the nutritional impact (33, 34).

Box 3 Clinical vignette: Feeding refusal

A 10-month-old infant has been breastfed since birth without any formula or micronutrient supplementation. He has had two episodes of repetitive, forceful emesis within 2 h following ingestion of oat cereal at the age of 5 months that was treated with intravenous rehydration in the emergency department. He has had milder emesis episodes followed by diarrhea with barley and sweet potato. He has been given a presumptive diagnosis of food protein-induced enterocolitis syndrome and referred for diagnostic oral food challenges. Following negative skin prick test, his parents were advised to add apples and butternut squash to his diet gradually at home. His mother has been reluctant to try these foods at home so an office oral food challenge has been carried out. During the challenge, he refused the foods consistently, pushing away the spoon and spitting up the contents. He also refused additional solids such as banana and pear. He was referred to a feeding specialist for evaluation and elemental semi-solid food was recommended as an alternative to improve feeding skills and provide an additional source of energy and micronutrients; specifically zinc. A multivitamin supplement was added to meet vitamin D and iron needs.

Key message: Breastfed infants with history of reactions to solid foods and delayed introduction of solid foods to their diet may develop feeding difficulties. The food refusal may be related to past unpleasant experiences with solid food. The problem can be compounded by parental apprehension about trying new foods because of past traumatic experiences. Counseling parents about strategies for enhancing feeding and oral skills is critical in these infants.

FPIES differs from proctocolitis and IgE-mediated allergies in that the breast-fed infant can typically continue nursing without maternal dietary avoidance of the allergen. Only rare cases of FPIES in exclusively breast-fed infants have been documented in the literature (32, 35, 36). Although breast milk is the ideal food for infants, eventually breast milk alone will not provide adequate nutrition. Energy and micronutrients (most notably iron, zinc, and vitamin D) are insufficiently

provided after 6 months of age (37). For those infants with milk or soy FPIES, the diet may be progressed with the addition of complementary foods at 6 months of age as recommended by the World Health Organization (WHO), American Academy of Pediatrics (AAP), the National Institute for Health and Clinical Excellence (NICE), and others. These infants do, however, have a greater chance of developing solid food FPIES, most commonly to rice and other grains (38). Therefore, introduction of yellow fruits and vegetables is often recommended prior to grains, and these fruits and vegetables may not provide the iron and zinc needed in this age group (32). If supplemental, substitute formulas are not in the diet, micronutrient supplementation may be required until the diet has greater diversity. The American Academy of Pediatrics (AAP) recommends iron supplementation (1 mg iron/kg body weight) after 4 months of age for infants who continue to breast-feed exclusively or for breast-feeding infants who have been weaned but do not have an adequate complementary dietary source of iron (39). Vitamin D supplementation is also recommended, although the recommendations may vary based on the specific country's guidelines. The AAP recommends vitamin D supplementation of 400 IU beginning shortly after birth. The NICE guidelines recommend supplementing Vitamin D in infancy from 6 months of age or sooner in circumstances of poor maternal vitamin D status. Breast milk provides sufficient zinc (2 mg/day) for the first 4–6 months of life, but for infants aged 7–12 months, who need 3 mg/day, breast milk alone is insufficient (40). Infants aged 7–12 months should consume age-appropriate foods or formula containing zinc or receive zinc supplementation, which has improved the growth rate in some children who demonstrate mild-to-moderate growth failure and who have a zinc deficiency (40). Good dietary sources of zinc are also more commonly allergenic such as whole grains and enriched cereals, milk, egg, meats, fish, poultry, legumes, tree nuts, oysters, and crustacean shellfish. Zinc is a nutrient that does not have specific guidelines for supplementation in infancy, although if the diet has been assessed and there are limited means to meet zinc needs via diet, a supplement may be added. The recommended dietary allowance (RDA) for zinc in infancy is 2 mg/day from 0 to 6 months and 3 mg/day from 7 to 12 months.

Eosinophilic esophagitis

Children with eosinophilic esophagitis (EoE) may have numerous nutritional risk factors such as chronic emesis, abdominal pain, poor appetite, food refusal, or other maladaptive-feeding behaviors. A subset of children with EoE has food allergies (41, 42). The only way to determine whether and which foods are implicated in EoE is to document resolution of EoE with specific food removal followed by a recurrence of disease when the specific food is reintroduced (43). As such, dietary management of EoE requires an elimination diet to determine trigger foods. The initial dietary intervention often entails the elimination of multiple potential allergens placing the child at further risk if the diet is not carefully planned with consideration of nutrient needs. Children with EoE require

careful nutrition assessment to ensure nutrient needs can be met in addition to regular follow-up as foods may be removed or added to the diet based on the child's response to the initial dietary intervention.

In some cases, a hypoallergenic semi-solid food (Neocate[®] Spoon available in the UK, Holland, Italy, Greece, Ireland, Sweden, Finland, Norway, USA, Australia, and New Zealand; Neocate[®] Nutra in the United States), supplemental hypoallergenic formula, and/or micronutrient supplementation may be suggested depending on the assessed nutritional needs. Infants and young children may initially refuse these formulas and supplements due to taste. One solution may be to mix a small amount of the hypoallergenic formula with breast milk and serve from a cup or bottle and very gradually increase the amount of hypoallergenic formula to breast milk. Many parents worry about the corn oil and corn syrup solids present in most formulas, but these corn ingredients do not contain significant corn protein and are typically tolerated by those with corn allergy (44).

Atopic dermatitis

Approximately 35% of children with moderate-persistent atopic dermatitis (AD) and sensitization to foods will have symptoms of food allergy upon challenge (45). Elimination of identified allergens has been shown to provide improvement of AD symptoms but should be combined with good skin care and pharmacotherapy when needed (46). Atopic dermatitis, however, has causes that are also not related to food allergies, and appropriate skin care is imperative. Patients who respond well to skin care treatment with minimal topical anti-inflammatory treatment are not likely to benefit from dietary intervention when no history of immediate food allergic reactions are reported. For those children with moderate to severe AD that cannot be controlled by optimal skin care management, a diagnosis of food allergy may be considered. The NIAID guidelines support the removal of suspected allergens as a useful technique to help identify potential triggers of AD (1). In an attempt to improve skin symptoms, however, parents may remove multiple foods without medical guidance, and children may be placed at nutritional risk. Elimination diets should always be initiated under medical and dietary guidance (47). The trial of an elimination diet should be followed by physician-supervised reintroduction of the food (food challenge) to prove allergenicity of the food. Following food avoidance (usually minimum 2 wk), more immediate manifestations of food allergy in children with AD can be seen during the food reintroduction such as urticaria, emesis, or even anaphylaxis (48). The NIAID guidelines do not recommend elimination of foods without proven allergenicity to control symptoms of AD (1).

Feeding and developmental needs

In addition to nutritional needs, infants with food allergies have the same developmental needs associated with eating as

their non-allergic peers. A healthy baby is born with the ability to coordinate sucking, breathing, and swallowing and so can nurse or take a bottle without having to be taught to do so. All other feeding skills are learned, however, so infants require the presentation of foods of appropriate textures to learn these skills. There appears to be critical periods in infant development when chewing and taste acceptance are more easily learned. For instance, when textured foods are introduced after 10 months of age, children are more likely to refuse solid foods; so, it is best if feeding opportunities can be presented when developmentally appropriate (49). If necessary, a commercial semi-solid hypoallergenic food may be provided.

Feeding appropriate textures can of course be more challenging for a child with food allergies and families may need more specific guidance as to what foods to introduce. An infant with milk and soy allergy may still be introduced to a variety of flavors and textures through grains, fruits, vegetables, and meats in an age-appropriate manner. Even an infant with a very limited diet can be provided variety of textures with a little creativity with the safe ingredients. For instance, a diet of only sweet potato can provide multiple textures. It can be mixed with breast milk (or a safe substitute formula) into a smooth, thin, or thick puree, mashed so that it has some lumps and bumps, or soft cooked and chopped so it provides an appropriate finger food texture. It can even be fried in a highly refined oil to provide some crunchy or crispier textures for older toddlers. Highly refined oils do not contain allergenic proteins so they are typically a safe option for children with food allergies (44).

Summary

Although the need for nutritional and dietary intervention is a common thread in food allergy management, the type of food allergic disorder and the identified food allergen will influence the approach to dietary intervention. A comprehensive nutrition assessment with appropriate intervention is warranted in all children with food allergies to meet nutrient needs and optimize growth. However, dietary elimination in food allergy may also have undesirable consequences. Frequently an elimination diet is absolutely necessary to prevent potentially life threatening food allergic reactions. Allergen elimination can also ease chronic symptoms, such as atopic dermatitis, when a food is proven to trigger symptoms. However, removing a food with proven sensitivity to treat chronic symptoms may increase the risk of an acute reaction upon reintroduction or accidental ingestion after long term avoidance so it is not without risk. Additionally, it is not recommended to avoid foods in an attempt to control chronic symptoms such as AD, EoE when allergy to the specific food has not been demonstrated. Ultimately, allergen elimination goals are to prevent acute and chronic food allergic reactions in the least restrictive, but also the safest environment to supply a balanced diet that promotes health and growth and development in children.

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