Nutritional management of food allergies

Marion Groetch, M.S., R.D.N.[1] and Carina Venter, Ph.D., R.D.[2]

ABSTRACT

Food allergy is a significant public health concern, with a rising prevalence. Elimination diets remain the cornerstone of food allergy management, and they are not without nutritional risk. Children who avoid nutritionally important foods, such as milk or multiple foods allergens, may be at greater risk. Even adults with food allergies may encounter challenges to meet current recommended dietary guidelines for health and reduced risk of chronic disease. The type of food allergy disorder will also impact nutritional risk. A food allergy affects food choices, nutritional intake, and health; therefore, guidance to provide nutritionally appropriate substitutes within the context of the elimination diet is invaluable.

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The term food allergy covers a broad spectrum of diseases, with both immunoglobulin E (IgE) and non–IgE-mediated mechanisms, each with its own nutritional implications (Table 1).[1,2,3,4] Certain non–IgE-mediated food allergy disorders, *e.g.*, food protein–induced allergic proctocolitis, present a lower nutritional risk, whereas eosinophilic esophagitis (EoE) and food protein–induced enterocolitis syndrome (FPIES) can result in significant disruptions in feeding, food choices, and nutritional intake. IgE-mediated food allergy can be mild or severe and life threatening. Eight nutritionally dense foods and food groups are responsible for the majority of food allergies: milk, egg, wheat, soy, peanut, tree nuts, fish, and crustacean shellfish. Sesame seems to be a rising allergen.[5,6]

The landscape of food allergy management is changing, with more options than ever before for prevention and treatment. Despite the development of food allergy therapies approved or being investigated, elimination diets remain the cornerstone of food allergy management. However, elimination diets are not without risk and avoidance education alone is not enough. The goal of food allergy dietary management is to prevent chronic and acute food allergic reactions through allergen elimination, while using an individualized approach to plan for balanced nutrition that promotes and maintains health in children and adults (Table 2).

NUTRITIONAL NEEDS THROUGH THE LIFE CYCLE

Food allergies occur in children and adults, and can impact nutrition at any stage of life.[7,8] The initial infant diet is one of either breast milk or infant formula to provide the nutritional foundations for growth and development. Food allergy at this life stage may impact infant formula choice and, potentially, the maternal diet, which, in turn, may influence the presentation of certain nutrients in breast milk.[9] By 6 months of age, breast milk alone is insufficient to meet nutritional needs, and complementary foods are recommended to provide additional energy, protein, and micronutrients (*e.g.*, zinc and iron).[10] Avoidance of common allergens, such as milk, egg, soy, and wheat, in infancy and early childhood can impact intake of these nutrients, and care must be taken to ensure that they are adequately replaced. In addition to providing nutrition, the infant and toddler years are the time to learn about different flavors and textures of foods, develop feeding skills, and acquire preferences for a diversity in the diet of healthy foods.

Adolescence is a second period of rapid growth, including skeletal growth and the onset of puberty, and comes with an increased need for nutrients such as calcium, phosphorous, magnesium, protein, calories, and zinc, and, in girls, iron. Adolescents and adults are more likely to have peanut, tree nut, fish, and/or shellfish allergy.[11] They are also more likely to have pollen food allergy syndrome than younger patients.[12] Pollen food allergy syndrome can impact the intake of fruits and vegetables, which provide

From the [1]Division of Pediatric Allergy and Immunology, Icahn School of Medicine at Mount Sinai, New York, New York, and [2]Section of Allergy and Immunology, University of Colorado Denver School of Medicine Children's Hospital Colorado, Aurora, Colorado

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Address correspondence to Marion Groetch, M.S., R.D.N., Division of Pediatric Allergy and Immunology, Icahn School of Medicine at Mount Sinai, 1 Gustave L. Levy Place, Box 1198, New York, NY 10029

E-mail address: Marion.groetch@mssm.edu

Table 1 **Potential nutritional risk of food allergy disorders**[1–4]

Food Allergy Disorder	Common Symptoms	Increased Nutritional Risk
Food protein–induced allergic proctocolitis	Specks or streaks of blood in stool; may also have mucous in stool, diarrhea; acute: moderate-to-severe presentations	Multiple food elimination diets in the quest for resolution of occult blood in stool is not required and may lead to nutritional risk; otherwise, no significant nutritional risk
Food protein–induced enterocolitis syndrome	Repetitive, forceful vomiting 1–4 hr after ingestion; may also have lethargy, pallor, dehydration, and shock (15–20%); chronic: chronic vomiting, diarrhea, failure to thrive, hypoalbuminemia	Age of onset in early infancy; altered complementary feeding schedule may limit nutritionally important foods; poor growth at presentation (chronic); negative experience with food; long-term elimination diets; risk of multiple food triggers; poor feeding skill acquisition
Eosinophilic esophagitis	Nausea and/or vomiting; regurgitation; chest pain; feeding difficulties; delayed growth; early satiety; abdominal pain; dysphagia with solid foods (more common in adolescents and adults)	Poor intake due to persistent symptoms; poor growth; multiple food, long-term elimination diets; poor compliance with elimination diets
Atopic dermatitis	Most common chronic, relapsing inflammatory skin condition in children-60% present in first year of life; dysregulation of the immune system, skin barrier dysfunction, and inflammation; characterized by pruritus and skin changes including xerosis, erosions and excoriations	The number of eliminated foods and nutritional value of that food will impact risk; untreated atopic dermatitis can result in sleep disturbance, increase energy, and protein needs that lead to poor growth; after food avoidance, more immediate manifestations of food allergy can be seen during food reintroduction, such as urticaria, emesis, or even anaphylaxis

important nutrition and are part of every prudent diet in the prevention of chronic diseases, *e.g.,* obesity, hypertension, cardiovascular diseases, diabetes. Cross-reactions among fruits, vegetables, and nuts have been described, ranging from milder oral symptoms to more severe reactions.[13,14] Adults should continue to focus on healthy eating because energy needs begin to decline with a shift toward maintenance of bone and muscle mass, and prevention of chronic disease. Older adults require fewer calories and certain micronutrients (*e.g.,* decreased recommended dietary allowance for iron in women >50 years) but also have greater needs for other nutrients (*e.g.,* increased recommended dietary allowance for vitamin D >70 years of age).[15,16]

Each stage of life requires attention to nutritional needs and common nutritional problems, which vary from one life stage to another. When managing food allergy, the unique needs of each patient must be considered (Fig. 1). A dietitian can identify the nutritional risk posed by the food allergy, food avoided, and life stage, and provide a patient-specific approach to managing the nutritional issues associated with food allergies.[17]

THE IMPACT OF FOOD ALLERGY ON GROWTH AND BODY WEIGHT

Growth

Poor growth in children with food allergies has often been reported, although not all children with food allergies have poor growth.[18] A recent international survey conducted across 10 countries found that 6% of children with food allergies were underweight, 9% were stunted, 5% were undernourished, and 8% were overweight.[19] Cow's milk elimination led to lower weight-for-height z scores than other food eliminations, and those with mixed IgE-mediated and non–IgE-mediated food allergies had lower height-for-age z scores than an IgE-mediated allergy alone. Growth of children with non–IgE-mediated food allergies was

Table 2 **Factors that may lead to increased nutritional risk in food allergy**

Cow's milk allergy
Multiple food allergies
Type of food allergy disorder (*e.g.*, FPIES, EoE, atopic dermatitis)
Eliminating foods of high nutritional value
Patient age of onset
Feeding difficulties or dysfunction
Additional non-allergy dietary restrictions
Inadequate substitution or supplementation in the elimination diet
Inability to manage food avoidance

FPIES = Food protein–induced enterocolitis syndrome; EoE = eosinophilic esophagitis.

affected more, indicated by lower weight-for-height and body mass index (BMI) than children with IgE-mediated food allergies. Growth of children with non–IgE-mediated food allergies may particularly be affected by low-grade inflammation of the gastric mucosa.[20]

However, growth of all children could be affected by some degree of systemic inflammation.[21–23] Other factors that could modify growth include the use of corticosteroids[24] and food restrictions.[25] Having additional allergic diseases, such as asthma, atopic dermatitis, or allergic rhinitis, did not seem to affect growth in this population. Overall, stunting (length/height for age z score < -2) was more common in this cohort than wasting (weight for length/BMI z score < -2). Not all children with food allergies are growth impaired, and almost equal numbers may be overweight as underweight; therefore, it is imperative to guide families toward appropriate allergen-free, healthy foods. In one study, conducted in young adults ages 17–22 years, the mean values of height z scores, but not of BMI or weight, were significantly reduced in those with cow's milk allergy (CMA) from a young age versus controls (-0.64 ± 0.9 versus -0.04 ± 0.7; $p = 0.001$).[26]

Assessing Growth

Food allergy guidelines in the United States recommend close growth monitoring for all children with food allergies.[27] Assessing growth is key in the evaluation of children as a measure of adequate nutritional intake and health. Weight is a sensitive indicator of adequate energy intake and is affected earlier than stature when caloric intake is insufficient. However, stature may be negatively affected by food allergy even before changes in weight velocity.[28,29]

Plotting serial measurements of the child's weight, length/height, BMI/weight for length and head circumference as age appropriate is an important way to assess growth velocity for that child because growth patterns in children tend to be predictable, and sudden or significant changes in growth patterns should trigger evaluation. Infants and children ages 0–24 months should have recumbent length, weight, and head circumference measured and plotted, along with weight for length on the World Health Organization growth charts for comparison with the population standard for healthy children. All growth charts are available from Center for Disease Control and Prevention (CDC) website.[30]

Children ≥ 2 years of age should have weight, standing height measured and, along with BMI plotted on the Centers for Disease Control and Prevention (CDC) growth charts for comparison with the reference population.[30] Children whose growth is reflected at <-2 (z score for weight for length/BMI or length/height) or >2 (z score for weight for length/BMI) standard deviations from the mean should be evaluated for under- or overnutrition, respectively. Dietitians can assist in the assessment of appropriate growth and, when using medical nutrition therapy, can intervene when children are growing poorly. The dietitian is uniquely qualified to provide medical nutrition therapy, which is an in-depth nutrition assessment and diagnosis, planning, and monitoring of the diet of a child at risk and with food allergies.

There currently are no studies that evaluated height and weight of adults with IgE-mediated food allergies, although unintentional weight loss is often reported in adults with EoE on elimination diets.[31] It, therefore, is recommended that height, weight, and BMI be assessed in adults who are following an elimination diet for the management of food allergies. Adults with food allergy will also benefit from medical nutrition therapy.

SPECIFIC FOOD ALLERGENS

Cow's Milk

CMA can present across the spectrum of food allergy disorders. CMA typically begins in infancy, which requires substitution of cow's milk formula with a substitute formula or maternal elimination of cow's milk if symptomatic on an unrestricted maternal diet while breast-feeding.[32] A time of greater nutritional risk is ~1 year of age, when children typically transition to drinking cow's milk from a cup. When to transition a child from breast milk or substitute formula to a milk substitute is based on the suitability of the child's nutritional intake from a varied solid food diet, eating skills and competence, and the ability to meet nutritional needs without breast milk or formula in the diet.[33] CMA guidelines suggest maintaining a cow's milk substitute of adequate nutritional value until 2 years of age (breast milk or formula) although this is not

Table 3 **Cow's milk allergy vignettes**

Vignette 1: 20-month-old with cow's milk allergy presents with iron deficiency anemia

Brief history: She is growing well and gaining weight but has a limited appetite and prefers to drink rather than eat

24-hr recall

Breakfast: Homemade white toast with peanut butter and jelly and 4 ounces of apple juice

Snack: 8 ounces pea protein beverage and half a banana

Lunch: 4 ounces soy yogurt, 1/2 cup of a fruit cup, 1 rice cracker, and 3 ounces pea protein beverage

Snack: 4 ounces applesauce and 8 ounces pea protein beverage

Dinner: 2 ounces chicken, 1 tablespoon of rice, 2 ounces carrots, 1/2 slice homemade white bread with milk-free margarine

Snack: Homemade cookie and 8 ounces of pea protein milk

Does this child need a nutritionally complete formula? Possibly, because of the following:

She is consuming 31 ounces total of milk substitute, much more than the recommended servings of milk substitute (16 ounces) for her age

She is getting the majority of her daily calories from a nutritionally incomplete beverage rather than solid food

She does not eat a varied solid food diet, and she does not eat enough solid foods

Her diet is low in vegetables, whole or enriched grains, and high in fruit and milk substitute

Her diet does not provide adequate iron

How can we help?

Add iron supplement to correct iron deficiency and devise a plan to include a balance of foods to meet nutritional needs

Discuss serving a balanced diet for a 2-year-old, which includes, approximately, 2 servings (16 ounces) of milk substitute, 3 ounces of grains (at least 50% whole grain and otherwise enriched grains), 1 cup of fruit, 1 cup of vegetables, and 2 ounces of protein-based foods (meat, fish, poultry, eggs, nuts, seeds, and legumes)

If balancing the diet is determined to not be possible at this time, transition to a tolerated toddler formula until the diet is varied and age appropriate

Vignette 2: 14-month-old child with multiple food allergies

Brief history: She is growing well with allergy to milk, egg, soy, peanut, tree nuts, green pea, and lentil; her mother would like to know if she can transition from formula to a plant-based beverage; she eats all grains, all fruits and vegetables, meat, fish, poultry, seeds, and some legumes (black, white, pink beans, and chick pea); she has a good appetite and requires some minor age-appropriate texture modification (chopped meats, soft cooked vegetables, *etc.*)

24-hr recall

Breakfast: 1/2 cup of oatmeal with chia seeds (2 tablespoons) and 1/2 cup of blueberries

Snack: hypoallergenic formula 4–6 ounces from a sippy cup, 1/3 banana

Lunch: 2 tablespoon black beans, 1 ounce chicken, 1/4 cup of whole wheat pasta with olive oil, 1/2 cup broccoli

Snack: 2 large cubes of watermelon, 1 whole-grain cracker with hummus

Dinner: 2 ounces of salmon, 1/4 of a large sweet potato, and 1/4 cup of zucchini with olive oil

Bed time: 6 ounces of hypoallergenic formula from a sippy cup

Does this child need a nutritionally complete infant or toddler formula? No, because of the following:

She has a balanced diet of foods from a variety of food groups and is taking ≤16 ounces of hypoallergenic formula; she is getting most of her nutrition from solid foods

Her infant formula has less calcium and vitamin D than the chosen milk substitute, and her solid-food diet provides the other nutrients provided by the formula

We discussed options and the parents chose a full-fat oat milk that has 160 calories per cup, 9 g fat, 3 g protein, and is fortified with 350 mg calcium and 3.6 μg vitamin D per cup

Table 3 **Continued**

Clinical Pearls when transitioning from formula or breast milk to an alternative milk substitute
Transition to a milk substitute when the child is at least 1 year of age and is able to meet all of the following criteria: Eat a varied solid-food diet with a variety of foods from each food group Get at least 2/3 of his or her calories from the varied solid-food diet Eat age-appropriate textures because acceptance of a food in a pureed form does not always translate to acceptance of the food in its natural texture Consume ≤16 ounces of milk substitute per day (this includes breast milk, formula, and other dairy substitutes [*e.g.*, yogurt]) and Get enough protein and fat and micronutrients in the diet from the solid foods and the available milk substitute Before 2 years of age, nutrition assessment is required prior to transition from breast milk or substitute formula

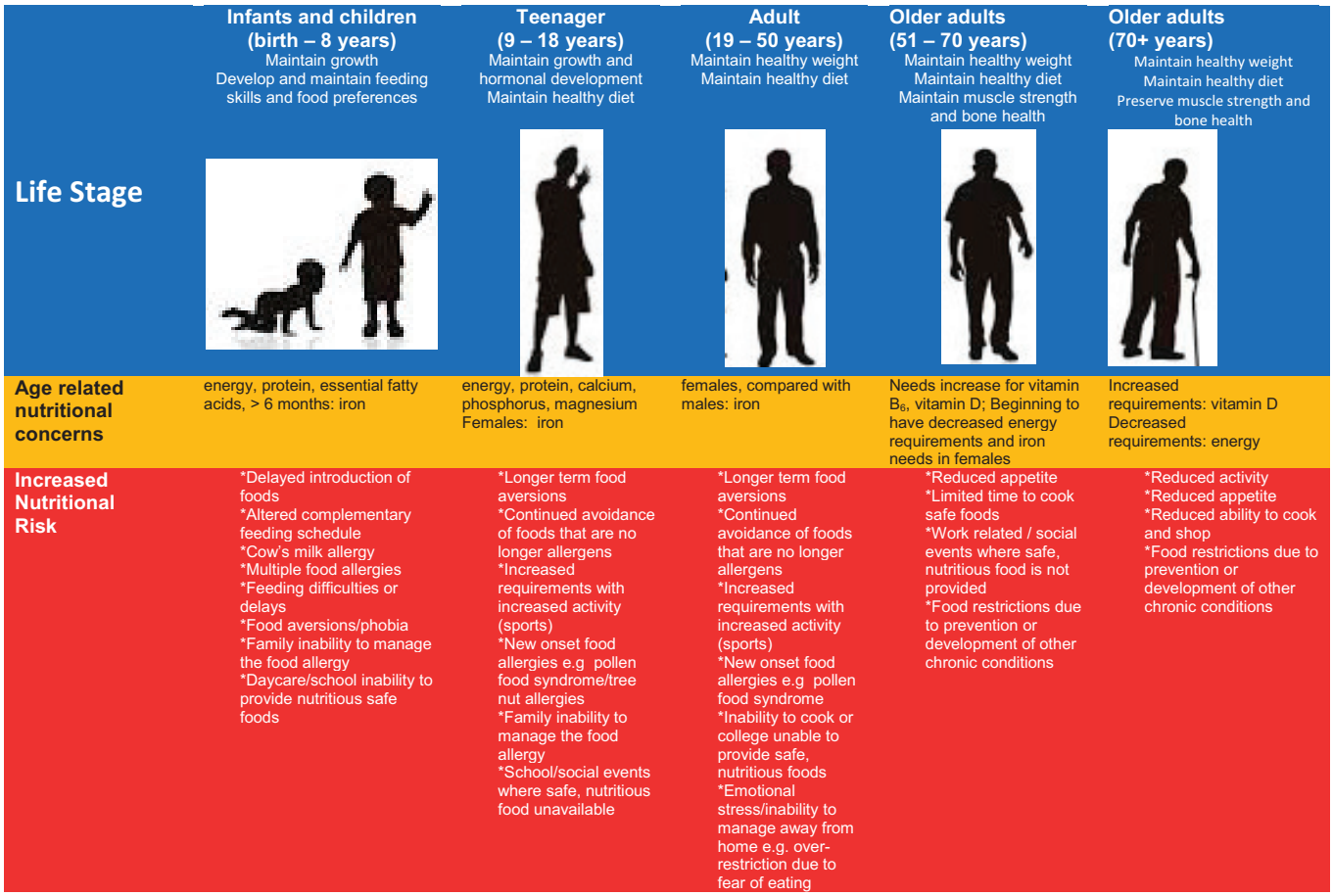

Figure 1. *Nutritional risk of food allergies across the life cycle Groetch and Venter.*[15,16]

always needed or beneficial depending on the dietary assessment of the child (Table 3).[33]

Cow's milk proteins cross-react with the majority of mammalian milks. It is suggested that those with CMA avoid ewe's milk and goat's milk due to homology of proteins. Milk from camel, dromedary, horse, donkey, and pig shows less structural similarity to cow's milk[33] but the practical use of these are problematic due to food safety, cost, and nutritional factors.[34] Meeting calcium needs in children and adults with CMA is a challenge,[35] and substitution via nutrient-rich foods (for instance, sardines or salmon with bones, greens such as

spinach and kale, chia seeds, almonds) or fortified foods (fortified plant-based milk products, cereal, calcium-set tofu) and/or supplementation is required (Supplemental Table 1 Calcium and Vitamin D). In general, it is difficult, but not impossible, to meet calcium needs with nondairy sources without fortified substitutes.

Of note, Maslin *et al.*[36] reported that children who consumed a cow's milk exclusion diet had higher scores for fussy eating than those who consumed an unrestricted diet, although both groups still scored within the normal range. In agreement with a report from Taylor *et al.*,[37] Maslin *et al*.[38] also reported that cow's milk exclusion in early life may lead to higher levels of food avoidant behavior up to 10 years after the cow's milk exclusion was discontinued. Discussing age-appropriate feeding and screening for feeding difficulties may be important in those with CMA. A recent study also indicated that young adults with CMA had a significantly lower intake of protein, vitamin A, vitamin B_{12} and riboflavin, calcium, potassium, phosphorus, magnesium, and zinc than their healthy controls.[26]

Hen's Egg

Hen's egg allergy does not itself pose nutritional risk because the nutrients in egg can be replaced by other foods and egg does not provide a large percentage of daily dietary intake in children or adults. Egg does provide a good source of protein, micronutrients, and two important carotenoids (lutein and zeaxanthin), which seem to provide protection against the development of age-related eye disease.[39] Hen's egg allergens cross-react with allergens from other birds.[40]

Baked Milk and Egg

Approximately 70% of those with CMA and hen's egg allergy will tolerate milk or egg when baked into a baked good with a grain matrix.[41–43] Including baked milk or egg in the diet when tolerated, does not appear to impact growth velocity or status of underlying allergic diseases, such as atopic dermatitis, asthma, and allergic rhinitis.[41] Although the inclusion of baked milk and egg ingredients can open up the diet and relieve the burden of strict avoidance, it comes with additional avoidance nuances. Families who include baked milk and egg in the diet require additional avoidance counseling (Table 4).

WHEAT

Wheat provides complex carbohydrates, B vitamins, iron, folic acid and whole wheat provides additional micronutrients and fiber. Gluten-free products are free of wheat protein (as well as rye and barley proteins). Many gluten-free products are made from rice, potato and corn starch and may not be fortified and therefore not nutritionally dense substitutes. However, there are many nutritionally dense wheat-free grains available such as amaranth, millet, quinoa, buckwheat, teff and sorghum.[44]

Wheat cross-reactions with other grains have been described and avoidance of rye and barley or other grains may be required in some individuals.[45] In addition to wheat avoidance, rice and oat may be avoided (or delayed) in those with FPIES. When these grains are avoided it is also common to delay introduction of other foods due to the increased risk of multiple food FPIES.[46] In breastfed infants >6 months of age avoiding grains, iron may be a nutrient of concern and alternative sources of iron such as red meat, ancient and pseudo grains or prophylactic iron supplementation (1 mg/kg/day) may be needed until dietary sources are sufficient.[3,47] (Supplemental Table 2 Iron)

Soybean

Soy beans are a good source of protein, unsaturated fatty acids, B vitamins, fiber, iron, calcium, zinc and other bioactive compounds and soy allergy can have a significant nutritional impact in those with concomitant CMA or if following a vegetarian diet. Highly refined soybean oil is not considered an allergen and does not require allergen labeling.[48] Although soy lecithin must be labeled as an allergen, studies show that the vast majority of soy-allergic individuals tolerate this ingredient.[49,50] It is uncommon to require avoidance of soy lecithin in those with soy allergy.

Peanut, tree nuts, fish and shellfish

Peanut, tree nuts, fish and shellfish allergy are more common in adults and provide important nutrition, in particular long chain polyunsaturated fatty acids (LCPUFA) from seafood and sources of alpha linolenic acid, fiber and plant based proteins from nuts. Cross-reactions between fish species and cross-reactions between shell fish allergen are often encountered and can be difficult to diagnose appropriately.[51] Cross-reactions between tree nuts are common and should be considered in the clinical management of tree nut allergies.[52,53]

A patient specific approach to management is required and allergy to one food (e.g., cashew or salmon) within a species does not necessarily necessitate avoidance of all foods within the species (tree nuts or fish).[17] However, care should be taken to avoid products with cross contact, which is common especially with peanuts and tree nuts that are often processed on shared lines.

Impact of Elimination Diet on Breast-Feeding: Improving the Maternal Diet

Food allergens have been detected in breast milk; however, the concentrations are often in the low nanogram per milliliter range, and, across studies, 25–50%

Table 4 **Avoidance education for baked milk and egg**

Allowed	Not Allowed	Caution
Ratio of ingredients in a baked product (*e.g.*, muffin, cookie, cracker, or roll) is dependent on volume tolerated in an oral food challenge: • Common published recipes allow 2 g of baked egg protein or 1.33 g of baked milk protein per serving • Based on the above amount, ratio should be $\leq$ 1 cup of milk or 2 eggs per 1 cup of flour, with a yield of 6 servings unless the patient has tolerated a higher dose on oral food challenge	• More milk or egg than what was tolerated on oral food challenge: • Dishes such as macaroni and cheese, lasagna, pizza are not baked goods and unless tolerated by oral food challenge, they should be avoided • Baked products such as angel food cake, frittata, quiche, *etc.*, may have more baked egg ingredient • Egg wash on outside of product	It is unknown if less matrix or more milk or egg will be tolerated but may be on an individualized basis
Store-bought baked milk and egg: • Commercial baked products with milk or egg ingredient listed as the third ingredient or further down the list of ingredients • This approach has been used successfully in multiple clinical trials; it is unknown if other products will be tolerated • Serving sizes are specified on the nutrition facts label	• Any commercial baked item with milk or egg as the first or second ingredient • Any unbaked milk or egg ingredient	Ensure the ingredient is a baked ingredient • A cheese-flavored cracker may have the flavoring topically applied after the cracker is baked • Cakes or cookies may have unbaked ingredients in icing, filling, or frosting • Remember to check products labels for other potential allergens
Cooking method and doneness • All baked milk and/or egg products must be baked in the oven and must be cooked throughout • A full-size muffin would typically be baked at 350°F for 30 minutes, as in common published baked milk and baked egg recipes	• Any item that is not a baked good (*e.g.*, lasagna or macaroni and cheese) or any item that is cooked but not baked, *e.g.*, pudding, custard, French toast, cooked eggs, or heated milk • Milk chocolate chips that will melt during baking but not "baked"; advise to use milk-free chocolate chips • Continue to avoid any unheated milk or egg ingredients	• Ensure items are baked throughout and not wet or soggy in the middle • Smaller muffins, cupcakes, cookies will bake for around 15 minutes; ensure that they are baked thoroughly; it is unknown if less baking time will sufficiently change allergenicity

of mothers who breast-feed had no detectable food allergen in breast milk after a maternal allergen load.[9,54–58] Nonetheless, clinical reactions to foods in infants exclusively breast-fed have been reported,[59,60] most commonly in food protein–induced allergic proctocolitis and less commonly in FPIES.

Maternal nutritional deficiencies will impact the presentation of certain nutrients in breast milk, such as thiamin, riboflavin, vitamin B_6, vitamin B_{12}, choline, vitamin A, vitamin D, selenium, and iodine, thus influencing breast-milk quality. Maternal elimination of major allergens, such as milk, egg, and fish, can reduce

rich dietary sources of many of these nutrients; however, breast-milk concentrations respond to maternal micronutrient supplementation.

The long chain polyunsaturated fatty acids (LCPUFA) eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) play a key role in infant growth and in cognitive and motor systems development. Bzikowska-Jura *et al.*[61] measured maternal dietary omega-3 fatty acid intake *via* a food-frequency questionnaire and 3-day food diary, and found a significant positive correlation between habitual fatty fish consumption and DHA concentration in human milk. Lactating mothers who avoid fish will benefit from other sources of omega-3 fatty acids, such as nuts and seeds (*e.g.*, walnut, flax, hemp, chia), which act as precursors to DHA and EPA; however, the conversion is not highly efficient (<10% conversion). The American Academy of Pediatrics recommends that women who are breastfeeding take 200 to 300 mg of n-3 LCPUFA to guarantee a sufficient concentration of preformed DHA in breast milk. Low-mercury fatty fish is recommended for all children and women of child-bearing years because of the importance of this nutrient in health and infant development.

Maternal deficiency of vitamin B_{12} can lead to deficiency in infants exclusively breast-fed, as documented in case studies.[62] Maternal intake of 6400 IU/day of vitamin D, which is >10 times the recommended intake, can increase breast-milk concentrations to provide sufficient vitamin D to the nursing infant. However, this is not typically recommended, and, due to low concentration of vitamin D in breast milk, the American Academy of Pediatrics recommends that infants who are breastfed receive vitamin D supplementation of 400 IU per day.[63] Other vital nutrients, such as calcium, iron, zinc, copper, and folate, are less dependent on maternal diet but inadequacy can impact maternal health.

Maternal dietary elimination is not without nutrition risk and should only be used when there is evidence of infant food allergy that resulted in allergic reactions after breast-feeding from an unrestricted maternal diet. In most cases, the diagnosis needs to be confirmed or excluded by a maternal allergen elimination diet and challenge procedure.[64] Maternal elimination diets, when necessary, should be guided by a dietitian who can assess and monitor the diet, and recommend alternative sources of needed nutrients for optimal infant and maternal health.

CHOOSING AN INFANT FORMULA; VITAMIN AND MINERAL SUPPLEMENTS

There are two types of infant formula recommended for use in infants and children with CMA: extensively hydrolyzed formulas (EHF) or amino acid-based formulas (AAF). EHF are typically based on cow's milk proteins that have been hydrolyzed into smaller peptides and are tolerated by 90% of infants with CMA, with a 95% confidence interval.[65] Tolerance to EHF may be lower in children with non–IgE-mediated CMA than with IgE-mediated disorders.[66–68] Rice hydrolyzates are also entering the market. Partially hydrolyzed formulas and formulas from Europe labeled "HA" or "hypoallergenic," do not meet criteria for hypoallergenicity in the United States and are not recommended for infants with CMA.[69]

Anaphylactic reactions have been described with both casein and whey hydrolyzates.[68,70,71] However, the majority of infants with CMA will tolerate any EHF. Luyt *et al.*[72] and Venter *et al.*[73] provide detailed discussion on CMA and the formulas available in the United Kingdom. AAF consist of pure amino acids (not cow's milk derived) and are well tolerated by infants and children with both IgE- and non–IgE-mediated food allergy.[74–76] AAF are useful in infants with the following[68]:

- Failure of symptom resolution with EHF
- Faltering growth, in particular, if multiple systems are involved, *e.g.*, gastrointestinal tract and skin
- Anaphylaxis
- EoE

The use of vitamin and mineral supplementation in managing children is often questioned. Meyer *et al.*[77] showed that children who were not receiving a hypoallergenic formula were at particular risk of nutrient deficiency and required a vitamin and mineral supplement. Nutrient deficiency risk is influenced by the food and the number of foods being excluded.[18] Ideally, vitamin and mineral supplementation should be provided in a targeted fashion after a detailed dietary assessment.[78]

COMPLEMENTARY FOODS: NUTRITION, FEEDING SKILLS, AND LEARNING TO EAT AND ENJOY A VARIETY OF FOODS

Feeding difficulties are commonly reported in those with food allergy.[79,80] These can present as limited appetite, selective eating, or fear of eating. Feeding difficulties can lead to further restriction of an already limited diet.[81] There are many factors that contribute to feeding difficulties in children with food allergies. Food allergy–related factors include discomfort when eating that leads to maladaptive eating behaviors and parental stress during meal times as well as reduced social opportunities to eat.[82,83] Non-food-allergy–related factors include late introduction of solid foods, delayed introduction of lumpy foods, and maternal stress; all of these are often associated in infants with food allergies.[84]

Introducing a variety of foods in infancy is important to meet nutritional needs. By 6 months of age, breast milk alone is insufficient to meet nutritional needs, and complementary foods are recommended to provide additional energy, protein, and micronutrients (*e.g.*, zinc and iron).[10] All infants, including those with food allergy, will need to begin feeding or receiving alternative sources of these nutrients. Complementary feeding is also important for feeding skill development. A lack of exposure to age-appropriate foods during the second half of the first year of life may lead to greater difficultly in acquiring feeding skills and flavor acceptance.[85]

In contrast to easier flavor and texture acceptance in infancy, when children are more likely to accept a new flavor on the very first exposure, 2–5-year-old children may need multiple exposures to a new food before significant increases in intake are noted.[86,87] Long-term feeding skills and food acceptance can be impacted with delayed feeding or when too much time is spent on introducing single food items.[88] In a longitudinal birth cohort study, 7821 mothers of children were surveyed about foods eaten and feeding difficulties in their children at various ages, up to 7 years of age. Children introduced to lumpy solids after the age of 9 months ate fewer of many food groups at 7 years, including fruits and vegetables, than those introduced to lumpy foods between 6 and 9 months ($p < 0.05$-0.001). In addition, they were reported as having significantly more feeding problems at 7 years ($p < 0.05$-0.001).[85]

Because children with food allergies have diets that already limit the provision of nutrients and caregivers may be less inclined to offer foods that have not been tolerated in the past, it is important to provide support and guidance. Dietitians can help by encouraging a variety of flavors of tolerated foods from all food groups and by supporting the progression from purees to greater textures when age and developmentally appropriate.

CONCLUSION

Food allergies are an increasing problem in the developed and developing world. Food allergies have the potential to affect nutritional intake, growth in children, and BMI in adults. Studies in children and adults indicate CMA, in particular, may affect nutritional intake. There are no studies that investigated decision points for referral to an allergy specialist dietitian, but we recommend considering referral of those with CMA of all ages and with multiple food allergies or with certain food allergy disorders (*e.g.*, EoE or FPIES); those who eliminated foods of high nutritional value; those with feeding difficulties or dysfunction, additional non-allergy dietary restrictions, or inadequate substitution or supplementation in the elimination diet; and those with an inability to manage food avoidance.

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