

Dietary Management of Food Allergy



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KEYWORDS

• Food allergy • Nutrition • Allergens • Malnutrition • Management

Continued

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KEY POINTS

- Food allergy management is based on an individualized approach, which includes information on food avoidance and suitable substitutes, equally important to maintain safety and growth.
- To ensure appropriate avoidance and prevention over restriction, up-to-date information is required about label reading, cross-contamination, and allergen cross-reactions.
- The nutritional consultation should also focus on overall nutrition, feeding behavior, and nutritional status.
- The dietitian plays an integral role in providing this information and ensuring that the family's quality of life is maintained.

INTRODUCTION

The World Allergy Organization¹ and the Institute of Medicine² state that the prevalence of food allergies is increasing dramatically. This increase is especially problematic in children, who are carrying the greatest disease burden. Worldwide food allergy prevalence ranges from 1.1% to 10.8%. Although prevalence figures differ depending on the country and age studied, the most important prevalent food allergens include milk, egg, peanut and tree nuts, fish and seafood, wheat, soy, and sesame.² Adverse reactions to foods are divided into IgE-mediated and non-IgE-mediated food allergies. Although the majority of this article focuses on IgE-mediated food allergies, reflecting current research, where available, data on non-IgE-mediated food allergies is also covered.

The dietary management of food allergies depends on a clear clinical diagnosis and the clinical history is key in obtaining the relevant information as outlined in the article by Skypala and colleagues.³ After the diagnosis, an individualized avoidance strategy includes appropriate avoidance of the trigger food(s), knowledge of suitable alternatives, and ensuring that the diet is nutritionally sound to support optimal growth and oral motor skill development.

FOOD LABELS

The mainstay of safe food allergen avoidance is knowledge regarding label reading. Food allergen labeling laws differ around the world and are summarized in **Table 1**. US food allergen labeling laws are governed by the US Food and Drug Administration's Food Allergen Labeling And Consumer Protection Act (<https://www.fda.gov/food/food-allergens/gluten-free-guidance-documents-regulatory-information/food-allergen-labeling-and-consumer-protection-act-2004-questions-and-answers>), in Canada by the Food and Drugs Act and the Safe Foods for Canadians Act (<https://www.inspection.gc.ca/food-safety-for-industry/toolkit-for-food-businesses/sfcr-handbook-for-food-businesses/eng/1481560206153/1481560532540?chap=0>), in Europe by the European Commission (https://ec.europa.eu/food/sites/food/files/safety/docs/codex_ccfl_cl-2018-24_ann-02.pdf), and the Food Standards Australia New Zealand (FSANZ) in Australasia (<https://www.foodstandards.gov.au/industry/labelling/pages/default.aspx>).

Food allergen labeling laws require that food manufacturers clearly identify ingredients considered major allergens using the food allergen's common name. Country or region-specific laws differ regarding which foods are considered major allergens. The US food labeling laws identify the major allergens requiring full disclosure as milk, egg,

Table 1
Food allergen labeling laws in the United States, the EU, Canada, and Australia/New Zealand

		US	EU	Canada	Aust/NZ
Allergens labeled	Celery		✓		
	Crustacean	✓	✓	✓	
	Egg	✓	✓	✓	✓
	Fish	✓	✓	✓	✓
	Cereal containing gluten (excluding wheat)	^a	✓	✓	✓
	Lupin		✓		✓
	Milk	✓	✓	✓	✓
	Mollusk		✓	✓	
	Mustard		✓	✓	
	Peanut	✓	✓	✓	✓
	Sesame		✓	✓	✓
	Soybean	✓	✓	✓	✓
	Sulfur dioxide and sulfites ^b	✓	✓	✓	✓
	Tree nut ^c	✓	✓		✓
	Wheat	✓	✓	✓ ^d	✓
Labeling statements allowed	"Contains"	✓		✓	✓
	Allergen emphasized in ingredient list	✓	✓	✓	✓
Precautionary allergen labeling	Voluntary	✓	✓	✓ ^e	✓
	Regulated				
Type of food labeled	Prepacked	✓	✓	✓	✓
	Prepacked for direct sale		✓ ^f		○
	Not prepacked		^g		○
Foods covered under allergen labeling laws	Over-the-counter or prescription drugs				
	Cosmetics and beauty products		✓ ^h		
	Meat, poultry, and egg products		ⁱ		
	Alcoholic drinks, wine, spirits, beer, and tobacco products		✓ ^j	^k	
	Pet foods				
	Fresh fruits and vegetables		ⁱ		
	Restaurant foods		ⁱ	ⁱ	
Exemptions ^m	Highly refined oils	✓		✓	
	Wheat-based glucose syrups		✓		✓ ⁿ
	Wheat-based maltodextrins		✓		
	Barley-based glucose syrups		✓		
	Cereals used in distillates for spirits		✓		✓
	Lysozyme (from egg) used in wine		✓		
	Albumin (from egg) used as a fining agent in wine and cider		✓		
	Ice structuring protein	✓			
	Fish gelatin used as a carrier for vitamins and flavors		✓		
	Isinglass used as fining agent in beer, cider, and wine		✓		✓
	Fully refined soybean oil and fat		✓		✓
	Tocopherols ^l		✓		✓
	Vegetable oils derived		✓		✓
	phytosterols and phytosterol esters from soybeans				

(continued on next page)

	US	EU	Canada	Aust/NZ
Plant stanol ester from soybeans		✓		
Soy lecithin used as a release or processing agent	✓			
Whey used in distillates for spirits		✓		✓
Lactitol		✓		
Milk (casein) products used as fining agents in cider and wines		✓		
Nuts used in distillates for spirits		✓		
Nuts used as flavor in spirits		✓		
Celery leaf and seed oil		✓		
Celery seed oleoresin		✓		
Mustard oil		✓		
Mustard seed oil		✓		
Mustard seed oleoresin		✓		

^a Although gluten does not have to be labeled in the United States, the US Food and Drug Administration defined the term gluten-free for voluntary use. For a product to be gluten-free, it must (1) not contain gluten-containing grains; (2) not be derived from a gluten-containing grain that has not been processed to remove the gluten; and (3) not be derived from a gluten-containing grain that has been processed to remove gluten, but still has ≥ 20 ppm gluten.

^b Not covered under the Food Allergen Labeling and Consumer Protection Act of 2004 in the United States but must be declared at concentrations of ≥ 10 ppm. In Canada, sulfites also must be labeled when ≥ 10 ppm. In the EU, sulfites must be labeled when in concentrations of > 10 ppm.

^c EU legislation only contains almond, brazil nut, cashew, hazelnut, macadamia nut, pecan, pistachio, and walnut; Canada also includes pine nut. Tree nuts in the United States include all of the above, as well as beech nut, butternut, chestnut, chinquapin, coconut, ginkgo nut, hickory nut, lychee, pili nut, and shea nut.

^d Also includes triticale.

^e It is recommended to use "may contain" instead of other precautionary labeling statements.

^f In effect October 1, 2021.

^g Allergen information must be supplied to the consumer, but labeling is not required.

^h There are 26 fragrance allergens that must be labeled if they are present in concentrations greater than 0.01% in rinse-off products or 0.001% in leave-on products. The allergens are alpha-isomethyl ionone, amyl cinnamal, amylcinnamyl alcohol, anise alcohol, benzyl alcohol, benzyl benzoate, benzyl cinnamate, benzyl salicylate, butylphenyl methylpropional, cinnamal, cinnamyl alcohol, citral, citronellol, coumarin, eugenol, farnesol, geraniol, hexyl cinnamal, hydroxycitronellal, hydroxyisohexyl 3-cyclohexene carboxaldehyde, isoeugenol, limonene, linalool, methyl 2-octynoate, Evernia prunastri, and Evernia furfuracea.

ⁱ These products are considered nonprepacked foods, and thus do not need to be labeled.

^j If there is $> 1.2\%$ alcohol by volume, the product does not need a full ingredient list, but must have a "contains" statement listing the allergens.

^k Allergens must be declared for beer, but not for other alcoholic drinks.

^l Natural mixed tocopherols (E306), natural D-alpha tocopherol, natural D-alpha tocopherol acetate, natural D-alpha tocopherol succinate from soybean sources.

^m No information found for Canadian exemptions besides highly refined oils.

ⁿ FSANZ Standard 1.2.3: Glucose syrups must have no more than 20 mg/kg detectable gluten to meet the requirements for an exemption from mandatory labeling of wheat.

^o FSANZ must be able to produce ingredient information, including allergen information if asked.

finfish, crustacean shellfish, peanut, tree nuts, wheat, and soy. Canada covers the same 8 foods and food groups in addition to sesame. In Australia and New Zealand, lupin, a legume, is also required. European food labeling laws identify the most extensive major allergen list including the 8 foods and food groups, lupin and sesame, but also celery, mollusks, and mustard. Sulfur dioxide and sulfites are included by all these

countries. Uniquely, though, coconut is considered a tree nut by US food allergen labeling but not by Canada, Australasia, or the EU.

Similarly, food allergens can be indicated in bold or parenthesis in the United States and Canada, but are highlighted by means of a distinguishing typeset, for example, bold or italics, in the EU. In most countries, major allergens must be listed either in the ingredient list or in a “contains statement”; however, in the EU, the use of contains statements are against the law. Labeling laws also differ in terms of which ingredients are being exempted. Irrespective of where the food is being produced, the food labeling should adhere to the labeling laws of the country where it is being sold.

Challenges can arise for families traveling to a country where their allergen is not considered a major food allergen. Only major allergens recognized by the country where sold require full disclosure on product labels. If avoiding an allergen not considered a major allergen, caution is warranted with foods that list natural flavors, colorings, additives, or other vague food descriptions in the ingredient list. The manufacturer should always be contacted if questions arise.

Key points to remember when educating patients about label reading include the following.

- Always check and recheck food labels, because ingredients or recipes may have changed.
- If there is any uncertainty about the allergen content of a food, it is best to call the manufacturer for clarification.
- Useful information about label reading can be obtained from patient and professional organizations.

Precautionary Allergen Labeling (PAL) includes statements such as “May contain...” or “Manufactured on the same equipment as...” or “Produced in the same facility as....” These precautions may follow ingredient lists and contains statements.⁴ All PAL indicate that cross-contact with trace amounts of the allergen may have occurred during manufacturing; however, no specific PAL statement indicates a greater exposure risk than the others. PALs are used voluntarily by food manufacturers and are not regulated. The decision to eat or avoid foods with PAL is individualized and should be discussed with the patient and their allergist.

GROWTH AND FEEDING ISSUES IN INDIVIDUALS WITH FOOD ALLERGIES

The onset of food allergies usually occurs in early childhood, a time of rapid growth, cognitive and oral motor development, and a period when feeding patterns are established.^{5,6} The mainstay of food allergy management is the elimination of the offending food.⁷ Many of the more common allergens contribute essential nutrients during this vulnerable time and inappropriate advice and alternatives may increase risk of growth faltering and nutrient deficiencies with potential long-term effects. Additionally, parental anxiety regarding the food allergy may worsen feeding practices ([Fig. 1](#)).^{8,9}

Faltering growth, in particular low height for age has been reported in children with both IgE- and non-IgE-mediated food allergies.^{9,10} The impact on growth is not only seen in young children, but also in young adults with persistent cow’s milk allergy,⁷ where low final heights were recorded in comparison with nonallergic young adults. There are also cases of more serious malnutrition disorders, including kwashiorkor and marasmus while following an excessive allergen elimination diet, without sufficient dietary support.^{11,12} Low intake of crucial micronutrients—particularly calcium, vitamin D, iron, and zinc—can negatively impact normal growth and development.^{13–16} Although the impact of nutritional intervention on growth is indisputable,^{8,10}

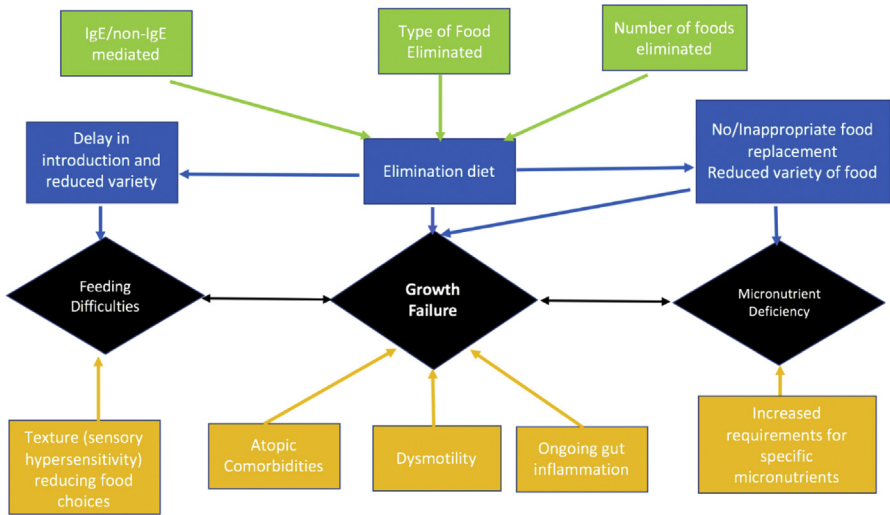


Fig. 1. Interplay between growth failure, micronutrient deficiencies and feeding difficulties. (Adapted from Meyer R. Nutritional disorders resulting from food allergy in children. *Pediatr Allergy Immunol* 2018;29(7):689-704; with permission.)

studies have highlighted the possibility of inflammation, including atopic eczema and gastrointestinal inflammation also playing a role.^{17,18}

Feeding difficulties are reported in between 40% and 90% of children with food allergies, depending on the definition used and the population studied.^{19,20} Although the majority of the data is produced in non-IgE-mediated allergies where abdominal discomfort plays a role in the origin of the aversive feeding,²¹ it is known that dietary elimination changes the modeling around food intake, may heighten anxiety around mealtimes and thereby disrupt the development of a positive association with food.^{22–24} There is a clear interplay between dietary elimination, feeding difficulties, dietary adequacy, and growth concerns in food allergy. Parental fear of an allergic reaction with new food introductions, perception of allergic reactions to multiple foods without clinical diagnosis and/or limited dietary education with appropriate substitutes, leads to dietary restrictions, poor feeding skills, and/or maladaptive feeding behaviors that can affect growth.²⁵ Moreover, studies indicate that having avoided a food for the first year of life owing to an adverse reaction, children continue with aversive eating and limited food choices, even when they overcome the specific food allergy.^{6,13}

Optimal nutritional management, therefore, plays a critical role in the avoidance and management of nutritional disorders related to food allergy. Evidence has indicated that dietary input from a registered dietitian improves both growth parameters and nutritional biomarkers as part of a multidisciplinary team.^{21,26}

Practical points to consider in the prevention and management of nutritional disorders related to food allergy

1. Ensure that regular and accurate weight, length, height, and where appropriate head circumference measurements are taken and plotted on appropriate growth chart/converted to z-scores using the World Health Organization's Anthro software (<https://www.who.int/childgrowth/software/en/>).

2. Act early when growth is faltering with optimal dietary management, which includes optimizing protein: energy ratio according to the World Health Organization/Food and Agriculture Organization/United Nations University guidelines outlined in [Table 2](#).²⁷
3. Assess micronutrient intake of all micronutrients (not only calcium/vitamin D) and perform targeted nutritional blood markers where necessary.²⁸
4. Be proactive in feeding advice, to ensure normal oral motor skill development by advising on age-appropriate introduction of tastes and textures.
5. When feeding difficulties are present, in addition to constructive feeding advice,²¹ ensure that medical management is optimal and that dietary requirements are met to support growth.

NUTRITIONAL IMPACT OF AVOIDANCE DIETS

Many of the common food allergens are found in core food groups, and the removal of these allergens from the diet will limit essential macronutrients and micronutrients. As such, it is important that appropriate substitutes are included in the diet. [Tables 3](#) and [4](#) summarize the main nutrients provided by common food allergens and suitable replacement foods for nutrients lost to the elimination diet. Below follows a detailed discussion of each of the main food allergens: milk, egg, wheat and grains, fish and seafood, peanut and tree nuts, soy, and sesame.

SPECIFIC FOOD ALLERGENS

Cow's Milk Allergy

Cow's milk allergy is one of the first food allergies to manifest in infants because it is the first potential food allergen to which infants are exposed.²⁹ Worldwide, it is estimated that cow's milk allergy has a prevalence of 1.0% to 4.9%,^{30,31} and although cow's milk allergy often resolves during childhood, it may persist into adulthood.³²

Dietary management of cow's milk allergy

Avoidance of all sources of cow's milk protein underpins the dietary management of cow's milk allergy. [Table 5](#) outlines the foods that should be avoided, and those that are safe to include in a cow's milk free diet. [Table 1](#) outlines labeling laws relating to cow's milk protein avoidance.

Cow's milk and cow's milk-containing foods contribute important energy, protein, calcium, phosphorus, and many other vitamins and minerals to the diet, making it essential that a nutritionally equivalent milk substitute is used.^{10,31} Cow's milk protein may be found as an ingredient in many foods, including foods one would not expect to find cow's milk (eg, baby teething rusks; tubes of herbs, bread, beef hot dogs, and tomato sauce). Cow's milk protein may also be present in medications, which are not covered by the US Food Allergen Labeling And Consumer Protection Act. Families

Table 2

Optimal protein: energy ratio according to the World Health Organization/Food and Agriculture Organization/United Nations University guidelines

Catch-Up Growth	Protein (g/kg/d)	Energy (kcal/kg/d)	Protein/Energy (%)
5 g/kg/d	1.82	105	6.9
10 g/kg/d	2.82	126	8.9
20 g/kg/d	4.82	167	11.5

Table 3
Nutrients provided by food containing common food allergens

Eliminated Food	Nutrients at Risk											
	Protein	Carbo-Hydrate	Fat	Fiber	Calcium	Vitamin D	Vitamin B ₁₂	Folate	Iodine	Biotin	Iron	Omega – 3 Fatty Acids
Milk	x	X	x		x	x	x		x			
Egg	x					x				x	x	
Wheat		x		x				x			x	
Soy	x		x	x	x			x		x	x	
Tree nuts and seeds	x	x	x	x								x
Seafood	x		x			x	x		x			x
Peanut				x								

Each food supplies specific nutrients that require attention when the food is eliminated to avoid inadequacies.

Table 4
Substitute foods for nutrients lost to the elimination diet

Calcium	Milk and dairy products, calcium-fortified plant beverages, calcium-set tofu, canned sardine or salmon with bones, fortified breakfast cereals	Children and adults
Vitamin D	Vitamin D fortified foods (in particular, milk and plant-based beverages but also breakfast cereals), Fatty fish, cod liver oil, UV light exposed mushrooms, egg yolk	Children and adults
Iodine	Seaweed, fish, milk, egg, enriched grains, iodized salt	Children and adults
Protein	Meat, fish, poultry, eggs, nuts, seeds, legumes	Children and adults
Fat	Vegetable oils, fatty fish, whole dairy products, meats, nuts, seeds	Children <4 years of age
Vitamin B ₁₂	Animal products and fortified foods (breakfast cereals, fortified beverages, fortified nutritional yeast)	Vegan dietary pattern
Omega 3 fatty acids DHA–Docosahexaenoic acid EPA–Eicosapentaenoic acid ALA–Alpha-linolenic acid	DHA and EPA: cold water fatty fish, marine algae-based supplements, algal oil ALA: nuts, (walnuts) seeds (such as chia, flax, etc), canola and soybean oil	Children and adults (especially important for cognitive development in children)
Biotin	Beef liver, salmon, egg, pork, beef, sunflower seeds, sweet potato	Pregnant and breastfeeding
Iron	Fortified breakfast cereals, oysters, beef liver, white beans, lentils, tofu, spinach	Young children, females with menses, pregnant
Folate	Beef liver, spinach, legumes, avocado, dark green vegetables, wheat germ and folic acid in fortified grains	Woman of childbearing years
Fiber	Whole grains, nuts, seeds, legumes, fruits and vegetables	Children and adults

When foods are eliminated, the nutrients lost to the elimination diet should come from other foods and/or dietary supplements.

need to be instructed on how to identify the presence of cow's milk in commercial foods, prepare suitable meals at home (Table 6), and avoid the ingestion of cow's milk protein in foods prepared outside of the home, including at school, restaurants, and social gatherings.³³

Table 5
Foods to choose and foods to avoid in cow's milk free diet

Food/Food Group	Foods to Choose	Ingredient/Foods to Avoid
Milk products and alternatives	The following plant-based milk alternatives: soy, pea, coconut, almond, seed, oat, and rice beverages, plant based cheese, plant based yogurt	The following (fresh, UHT, dried, condensed, or evaporated): cow, goat, sheep, and other animal milks (camel, buffalo), butter, buttermilk, cheese, cream, creme fraiche curds, custard, ghee, half and half, ice cream, milk fat, milk protein, pudding, sour cream, yogurt, cottage cheese
Meats and other protein-rich foods	The following prepared without milk or milk ingredients (fresh, frozen, canned, dried, cured, processed, smoked, or brined): beef, pork, lamb, other meats, poultry, fish, seafood, nut, nut butters, seeds, beans, tofu, eggs (avoid meats sliced on the same equipment as milk containing products such as cheese)	The following prepared with milk or milk ingredients (batters, sauces, toppings, breading): beef, pork, lamb, other meats, poultry, fish, seafood, nut, nut butters, seeds, beans, tofu, eggs (avoid meats sliced on the same equipment that may lead to cross-contact with milk)
Grains	The following prepared without milk or milk ingredients: grains, breads, cold cereals, hot cereals, breads, baked goods, crackers, pasta, pancakes, waffles, chips, pretzels, and tortillas	The following prepared with milk or milk ingredients: grains, breads, cold cereals, hot cereals, baked goods, crackers, pasta, pancakes, waffles, chips, pretzels and tortillas
Fruits	Pure fruits (fresh, frozen, canned, pureed, juiced, and dried)	Fruits prepared with milk and milk ingredients
Vegetables	Pure vegetables (fresh, frozen, canned, pureed, juiced, and dried)	Vegetables prepared with milk and milk ingredients
Fats	Vegetable oils, seed oils; margarine, gravies, sauces and salad dressings made without milk ingredients; canned coconut milk	The following prepared with milk or milk ingredients: butter, butterfat, cream, ghee; margarine, gravies, sauces and salad dressings
Ingredients/miscellaneous	The following ingredients do not contain milk unless otherwise noted: calcium lactate, cocoa butter, cream of tartar, herbs, lactic acid (although lactic acid starter culture may contain milk), pepper, salt, spices	Milk, casein, casein hydrolysates, caseinates, diacetyl, lactalbumin, lactoferrin, lactoglobulin, lactose, lactulose, milk protein hydrolysates, milk protein, recaldent, rennet, casein, simplesse, sour milk solids, tagatose, whey (in all forms)

Table 6
Substitutes for milk in baking and cooking

Ingredient	Substitute
Cow's milk	For recipes calling for 1 cup or less of milk: Substitute equal amounts nondairy, plant-based "milk." For recipes calling for 1 cup or more of milk: Substitute 7 fluid oz. nondairy, plant based "milk "per 8 fluid oz. of dairy milk.
Butter	Allowed margarine, shortening or oil. In baking stick margarine may be preferable to tub margarines
Buttermilk	Add 1 tbsp vinegar (or lemon juice) to 1 cup of alternative, nondairy, plant based "milk." ^a
Cheese	Avocado, bean ,or legume spread, commercially available options
Sour cream	1 cup tofu blended with 1–2 teaspoons lemon juice, commercially available options

^a Curdling will settle once the item is baked/cooked.

Infants

Cow's milk allergens including β -lactoglobulin have been identified in the breastmilk of some but not all breastfeeding mothers, regardless of the milk content of the maternal diet.³⁴ For many infants with cow's milk allergy, the maternal diet does not need to be restricted.^{35,36} If a maternal elimination diet is required, the maternal diet should be evaluated for nutritional adequacy for maternal and infant health. In cases where infants with cow's milk protein allergy are asymptomatic on an unrestricted maternal diet, unnecessary maternal dietary avoidance should be discouraged.^{35–37}

It is essential that infants not breastfeeding are prescribed a suitable substitute formula that is free from cow's milk protein.³⁷ Hypoallergenic formulas in the United States, must demonstrate that at least 90% of infants with cow's milk protein allergy tolerated them with a 95% confidence interval and extensively hydrolyzed cow's milk protein formulas (casein or whey) and amino acid–based formulas meet this criterion.^{38,39} Other potential substitute milk-free formulas are made from soy protein isolate or hydrolyzed rice protein. Infant formula based on partially hydrolyzed cow's milk protein is not recommended for the management of cow's milk allergy.⁴⁰

Toddlers and older children

Children with cow's milk allergy should use a substitute formula or breast milk until 2 years of age,⁴¹ given their extra nutritional needs for growth and development (see section on growth and food allergy). Plant-based fortified beverages can be used in cooking or in cereal for most babies over 6 months of age if there are no concerns about growth. It is important to choose one that has added calcium. A dietitian will be able to advise on the best alternative taking the child's food allergies and nutritional intake into account.⁴² However, if there are no growth concerns and/or feeding difficulties, and after a nutritional assessment it is determined that the infant's nutritional needs can be met with a plant-based beverage in combination with the solid food diet, a dietitian may suggest an earlier transition. This point is especially true in light of the proliferation of a wider range of plant-based beverages with better nutritional profiles. Not all of these beverages are nutritionally equivalent to cow's milk; the protein and fat content varies significantly among the various beverages available and the bioavailability of the nutrients may be limited.^{33,43} Consultation with a dietitian is strongly recommended to ensure adequate nutrient intake in infants and children

with cow’s milk protein allergy, especially before a transition from breast milk or formula to a plant-based beverage.

Teens and adults

There is emerging evidence pointing to an increased incidence of cow’s milk allergy among teens and young adults.^{32,44} The management of cow’s milk allergy in this age group becomes more difficult as individuals eat away from home more frequently and become independent in their food choices. It is essential that teenagers and young adults have ongoing education and monitoring with their allergist.^{30,31} Alternative sources of calcium can be found in [Table 7](#).

Key points regarding cow’s milk allergy

- Complete avoidance of cow’s milk protein is required unless tolerance to baked milk develops in IgE-mediated allergy. Baked milk can be tolerated by a significant percentage of children with cow’s milk allergy and should be introduced timely under allergist recommendations and supervision⁴⁵(see section on Baked Milk and Baked Egg).
- Complete avoidance of cow’s milk protein is also required in non-IgE-mediated allergy, but a milk ladder may be trialed, if this is local practice, to establish tolerance to baked milk, cheese, yogurt, or other forms of processed milk.
- Plan for adequate micronutrient and macronutrient intake on cow’s milk free diet.
- Appropriate formula (in non-breast-fed infant) or plant-based milk substitute (>2 years of age) should be chosen to replace important nutrients and support growth.
- Ongoing management of teens or adults with milk allergy is recommended.

Hen’s Egg Allergy

IgE-mediated egg allergy is one of the most common food allergies, with an estimated incidence ranging from 0.5% to up to 8.9%.^{46,47} Clinical tolerance to egg is usually acquired by two-thirds of children with egg allergy by 5 years of age; however, recent evidence suggests an increasing persistence of egg allergy with tolerance developing later in childhood.^{48,49} Tolerance to well-baked egg (defined as egg mixed thoroughly with a grain creating a matrix, then heated at a temperature >350° F for 30 minutes) is usually achieved before tolerance to partially cooked or raw, unbaked, or less heated

Table 7 Alternative sources of calcium		
Category (Serving Size)	Food/Beverage	Calcium (mg)
Beans/Legumes (1 cup or 175 g cooked)	Soybeans (immature)	260
	Navy beans	125
	Black beans	120
Fish (3 oz or 84 g cooked)	Sardines	110
	Perch	85
	Shrimp	75
Nuts and seeds (1 oz or 28 g)	Almond	75
	Chia seeds	180
	Flax seeds	70
Fruits (2 oz or 56 g)	Figs	90
Vegetables (1 cup cooked)	Broccoli	60
	Bok Choy	160
	Collard greens	268

forms of egg.^{48,49} However, for IgE-mediated allergy, other forms should not be trialed unsupervised. Eggs contain a wide range of important nutrients including, iron, zinc, protein, and vitamins A, B₁₂, and D. **Table 8** provides details on which foods to avoid alongside foods to choose in the management of an egg-free diet.

As an ingredient, eggs are included in many foods to provide binding and aeration. Although commercial egg replacers are available, many other foods can be used in place of egg in recipes. **Table 9** outlines common substitutes for egg in baking and other foods products.

Unexpected sources of egg

Unexpected sources of egg may include the following: pasta, pizza crust, ice cream, candy, and cake frosting. Egg may also be present in craft paints, and children with egg allergy should not be allowed to play with egg cartons owing to the risk of exposure to raw egg. Some traditional cultures use egg white as a topical treatment for burns, which may place the egg-allergic individual at risk of severe reactions.

Key points regarding egg allergy

- The incidence of egg allergy seems to be increasing and has reached almost 10% in some countries.
- Choosing an appropriate egg substitute in baking or cooking depends on whether the egg in the recipe is being used for binding, leavening, or thickening.
- Baked egg tolerance occurs in as many as 70% of children with egg allergy.
- Baked egg or advancement of egg into the diet in IgE-mediated allergy should be introduced under a physician supervised oral food challenge.

Baked Milk and Baked Egg

Heating disrupts the structure of the conformational epitopes in cow's milk and egg proteins, making them less allergenic. Up to 70% children with cow's milk or egg allergies can tolerate baked milk or egg (baked in a flour matrix) before they tolerate unbaked milk or less well-cooked forms of egg.⁵⁰ The addition of baked milk or egg in the diet may improve the nutritional profile, reduce avoidance burdens, and promote inclusion in social activities for children.⁵⁰

For children with IgE-mediated cow's milk and egg allergies, the timing and place of introduction to baked milk or baked egg should be discussed with the treating allergist. This is because of the risk of severe allergic reactions.⁵⁰ Once baked milk or baked egg is introduced into the diet, it is important that they are consumed regularly to maintain tolerance.⁵⁰ **Box 1** gives some examples of recipes for baked milk and baked egg products, as well as suggestions for modification of recipes to include less sugar and more fiber. After a baked egg or milk challenge has been passed, individuals should be educated about nonbaked sources of the allergen that they should continue to avoid, such as the milk in milk chocolate chips, or egg in frosting or egg, and/or milk in less well-cooked cake (eg, mud cake or other cakes with a less-baked center).

Wheat and Other Grain Allergies

The prevalence of reported reactions to wheat is 3.6%, but only 0.1% of those have IgE-mediated wheat allergy confirmed by oral food challenge.⁵¹ Wheat allergy usually manifests in early childhood, with a median age of onset of 7 months, often on first ingestion.^{52,53} Barley is also a relevant allergen in some populations, as are wheat substitutes, such as buckwheat and quinoa.^{54–56} Wheat allergy usually resolves in childhood, with most children experiencing resolution by the age of 6 years.⁵⁷ In adults, wheat is a common cause of food-dependent exercise-induced

Table 8
Foods to choose and foods to avoid in an egg-free diet

Food Group	Foods to Choose	Foods/Ingredients to Avoid
Meat and other protein-rich foods	The following prepared without egg or egg ingredients (fresh, frozen, canned, dried, cured, processed, smoked, or brined): beef, pork, lamb, other meats, poultry, fish, seafood, nut, nut butters, seeds, beans, tofu, cheese	The following prepared with egg or egg ingredients (batters, sauces, toppings, breading): beef, pork, lamb, other meats, poultry, fish, seafood Egg, dried egg powder, egg substitutes that include egg ingredients
Dairy	The following prepared without egg or egg ingredients: cheese, cream cheese, heavy cream, milk (including condensed, evaporated or dried), yogurt, ice cream, pudding	The following prepared with egg or egg ingredients: ice cream, pudding, custard Eggnog
Grains	The following prepared without egg or egg ingredients: breads, crusts, baked goods (brownies, cakes, cookies, muffins, scones), cereals, crackers, enriched grains, whole grains, noodles, pasta, pancakes, rolls, waffles	The following prepared with egg or egg ingredients: breads, crusts, baked goods (brownies, cakes, cookies, muffins, scones), cereals, crackers, enriched grains, whole grains, noodles, pasta, pancakes, rice, rolls, waffles
Fruits	Pure fruits (fresh, frozen, canned, pureed, juiced, and dried)	Fruits prepared with egg or egg ingredients such as cakes, cookies, sauces, breads.
Vegetables	Pure vegetables (fresh, frozen, canned, pureed, juiced, and dried)	Vegetables prepared with egg or egg ingredients (batters, sauces, toppings, breading) or vegetables prepared in a fryer which is used for egg containing products
Fats/oils	The following prepared without egg or egg ingredients: Butter, cream, margarine, oils; gravies, sauces and salad dressings, plant based mayonnaise substitutes	The following prepared with egg or egg ingredients: gravies, sauces (ie, bearnaise, hollandaise), salad dressings, mayonnaise
Desserts/other	The following prepared without egg or egg ingredients: cakes, cookies, ice cream, popsicles, pudding, frosting, buttercream	The following prepared with egg or egg ingredients: custard, frosting, ice cream, meringue, mousse, nougat, marshmallow, marshmallow spreads, sherbet, sorbet, souffle, marzipan or cake decorations

(continued on next page)

Table 8
(continued)

Food Group	Foods to Choose	Foods/Ingredients to Avoid
Ingredients	Gelatin, herbs, pepper, spices	Albumin, apovitellin, avidin, egg, egg white, egg yolk, globulin, livetin, lysozyme, ovalbumin, ovoglobulin, ovomucin, ovomucoid, ovovitellin, vitellin

anaphylaxis.^{58–60} Reactions can occur in the absence of cofactors, if sufficient wheat has been consumed.⁶¹ Some reactions to wheat products are not owing to wheat allergy; anaphylaxis to pancakes has reported to have been triggered by allergy to cereal mites (insects).⁶² This important differential diagnosis emphasizes the need to take a detailed food allergy history.³ Owing to cross-reactivity, a positive test to wheat may not be clinically relevant in grass-sensitized individuals, whereas the wheat allergen omega 5 gliadin has excellent diagnostic specificity and sensitivity.^{63–66}

Wheat can trigger occupational asthma owing to workplace exposure to flour and is also a common trigger of eosinophilic esophagitis.^{67–69} Celiac disease (CD), the other major condition linked to wheat ingestion, is an autoimmune disease triggered by gluten causing chronic inflammation, villous atrophy, and malabsorption in the small intestine in genetically predisposed individuals.^{70,71} The IgA class of anti-tissue transglutaminase and/or endomysial antibodies can indicate CD but an intestinal biopsy is mandatory to confirm diagnosis.⁷² Around 8.4% of individuals are affected by wheat allergy or CD, but many adults consider they are wheat intolerant or have nonceliac gluten sensitivity.^{73–75} Symptoms related to suspected nonceliac gluten sensitivity are often not caused by gluten, but by wheat carbohydrates, for example, fructans, prompting the suggestion that nonceliac gluten sensitivity be renamed nonceliac wheat sensitivity.^{76,77} Wheat avoidance may also be due to the perception that a wheat-free diet is part of a healthier lifestyle.^{78,79}

Table 9
Substitutes for egg in baking and cooking

Use	Substitute
Baked goods: leavening	In place of one egg: 1½ tbsp water, 1½ tbsp oil and 1 tsp baking powder 1 tsp baking powder, 1 tbsp water, and 1 tbsp vinegar
Baked goods: binding	In place of 1 egg: Mix 1 tbsp ground flaxseed and 3 tbsp warm water; let stand 1 minute before use 1/4 cup either fruit puree (applesauce, banana), silken tofu, or plain yogurt 1 packet gelatin and 2 tbsp warm water Prepackaged egg substitutes often made from potato and tapioca starch Liquid leftover from canned or freshly cooked chickpeas, 3 tbsp Xanthan gum: 1 tsp per recipe can help with binding and texture enhancement
Thickening	Add additional flour, starch

Box 1**Baked milk and baked egg recipes****Basic baked egg muffin recipe**

Developed by The Icahn School of Medicine at Mt. Sinai, NY, NY

Yield: 6 Muffins

Serving size: 1

Egg protein per serving: 2 g

Ingredients**Dry ingredients**

1 cup (125 g) all-purpose flour (wheat)

½ cup (100 g) sugar

¼ teaspoon (1.5 g) salt

1 teaspoon (4.6 g) baking powder

Wet ingredients

2 Tablespoons (30 mL) canola oil or other tolerated vegetable oil

½ teaspoon (2.5 mL) vanilla extract

2 large eggs, beaten

½ cup (120 mL) milk (cow's milk or plant-based substitute)

Directions

1. Preheat oven to 350° F (180° C). Check the oven is fully preheated.
2. Line a muffin pan with 6 muffin liners or grease the muffin tins with allowed butter (if not cow's milk allergic) margarine or oil spray.
3. Stir together wet ingredients until well combined. Set aside
4. In a separate bowl mix together the dry ingredients.
5. Add wet ingredients to dry ingredients all at once and gently stir until wet and dry ingredients combined. Do not over-mix. Some lumps may remain
6. Divide the batter into the 6 muffin tins, evenly.
7. Bake for 30 to 35 minute or until golden brown and firm to touch. Do not use muffins if soggy, gooey, or unbaked inside.
8. Cool completely before serving.

Baked Egg Muffins, reduced sugar recipe

This recipe makes 6 muffins.

Developed by The Icahn School of Medicine at Mt. Sinai, NY, NY

Developed by Wendy Elverson, RD, LDN

Yield: 6 muffins

Serving size: 1 muffin

Egg protein per serving: 2 g

Ingredients**Dry ingredients**

1 ¼ cups (155 g) all-purpose flour (or ½ cup white whole wheat flour and ¾ cup all-purpose flour)

¼ cup sugar (50 g)

¼ (1.5 g) teaspoon salt

2 teaspoons (9 g) baking powder

1 teaspoon (2.5 g) cinnamon (optional)

Wet ingredients

1 cup (240 mL) allowed "milk" beverage (cow's milk or plant-based alternative)

2 Tablespoons (30 mL) canola oil

1 teaspoon (5 mL) vanilla extract

2 large eggs, beaten

Directions

1. Preheat oven to 350° F (180° C)
2. Line a 6-cup muffin pan with paper liners, or grease muffin tins with allowed butter, margarine or oil spray.
3. In a bowl mix together wet ingredient. Set aside.
4. In a separate bowl mix dry ingredients.

5. Gradually whisk liquid ingredients into dry ingredients until fully combined. It is ok if there are some lumps in the batter.
6. Bake at 350° for 25 to 30 minutes or longer if needed. A toothpick or knife inserted in the middle should come out clean. Do not use muffins if soggy, gooey or unbaked inside.

Basic baked-milk muffin

Yield: 6 muffins

Serving size: 1 muffin

Milk protein per serving: 1.3 g

Ingredients

Dry ingredients

1 ¼ cup (155 g) all-purpose flour

½ cup (100 g) sugar

¼ teaspoon (1.5 g) salt

2 teaspoons (9 g) baking powder

Wet ingredients

1 cup (240 mL) milk (Cow's milk or allowed plant based "milk")

2 Tablespoons (30 mL) canola oil

1 teaspoon (5 mL) vanilla extract

1 egg (or equivalent replacer such as Ener-G® foods egg replacer)

Directions

1. Preheat oven to 350° F (180° C). Be sure oven is completely to this temperature.
2. Line a muffin pan with 6 muffin liners or grease times with allowed butter, margarine, or oil spray.
3. Stir together wet ingredients until well combined (including egg or egg replacer even though egg replacer is a dry ingredient). Set aside.
4. In a separate bowl mix together the dry ingredients.
5. Add wet ingredients to dry ingredients all at once and gently stir until wet and dry ingredients are just combined. Do not over-stir. Some small lumps may remain.
6. Divide batter evenly into the 6 muffin tins.
7. Bake 30 to 35 minutes or until golden brown and firm to the touch. Do not use muffins if soggy, gooey, or unbaked inside.
8. Cool completely before serving.

Baked milk 50% whole wheat bread

Developed by Wendy Elverson, RD, LDN

~ 1 ½ pound loaf

Serving size: 1/12 of loaf, ~2oz (1.2 g milk protein)

Servings per loaf: 12

Milk protein per serving: 1.2 g

Ingredients

1 cup plus 2 tablespoons room temperature water

1 tablespoon canola oil

1 teaspoon salt

1 ½ cups white whole wheat flour

1 ½ cups bread flour

46g nonfat dry milk powder (14 g protein)

1 tablespoon honey

2 teaspoons active dry yeast

Instructions

Add ingredients to bread machine in the order recommended by your machine.

Use basic or whole wheat cycle.

Once bread is ready, remove from the bread maker and place on a wire rack, let it cool fully before slicing. Once baked and cooled, weigh the full loaf. Divide weight by 12, and this value will be the amount of 1 serving of bread. Alternatively, if you do not have a kitchen scale, cut the bread into 12 equal size pieces.

Serving size: 1 piece

Baked egg and baked milk tips

- Consider a bread maker (46g dry milk powder and/or 1 egg can be added per 1.5 pound or 680 g loaf of bread).
- Pair bread and muffins with a nutrient dense food or spread.
- Add moistness to muffins using pumpkin, apple, banana, or zucchini.
- Cut the sugar: many recipes can decrease the sugar to 2 to 3 tablespoons per 6 muffins.
- Incorporate whole grain flours (oat, buckwheat, whole wheat, or sorghum).
- Add ground flaxseed, wheat germ and nonprocessed wheat bran for fiber.

Developed by The Icahn School of Medicine at Mt. Sinai, NY, NY, and Wendy Elverson, RD, LDN.

Dietary management of wheat and other grain allergies

Wheat allergy and CD require complete exclusion of wheat, including ancient varieties for example, spelt, einkorn, and emmer (**Table 10**).⁸⁰ Those who have CD must also avoid barley, rye, and kamut, whereas children allergic to wheat may tolerate rye, although barley may cause symptoms in some children.^{81,82} Excluding grains can result in nutritional deficiencies, owing to their importance as a major provider of energy, iron, and B vitamins. Gluten-free products often cost more than comparable wheat-based products; they also contain less protein and fiber, and often more fat and sugar.⁸³ Studies suggest that, the diets of those with CD are unbalanced, with often poor knowledge of and adherence to a gluten-free diet.^{84,85} Thus, the involvement of a dietitian is essential to ensure appropriate nutritional intake in individuals of all ages, for whom the dietary exclusion of wheat and grains is necessary.

Key points regarding wheat allergy

1. Wheat allergy is most prevalent in young children; new-onset wheat allergy in adults often manifests as a trigger of food-dependent exercise-induced anaphylaxis.
2. Wheat can also trigger non-IgE-mediated food allergies, including eosinophilic esophagitis, CD, and occupational asthma.
3. Optimal diagnosis of wheat allergy can be achieved through a detailed diet and clinical history and testing to the wheat allergen omega 5 gliadin.
4. Symptoms attributed to gluten sensitivity are more likely to be due to wheat carbohydrates such as fructans.
5. Excluding wheat and other grains can adversely affect nutritional status; dietary advice from a qualified professional is recommended for those with a wheat allergy or CD.

Soy and Legume Allergies

Soybean (glycine max) is well-recognized as allergenic and is one of the 8 most commonly allergenic foods worldwide. The prevalence of soy protein allergy among all children is 0.4%⁸⁶ with a high rate of resolution (45%) by age 6 or 7.^{87,88} IgE-mediated reactions, that is, food-dependent exercise-induced anaphylaxis,^{89,90} non-IgE-mediated, that is, food protein-induced enterocolitis syndrome,⁹¹ as well as mixed IgE-mediated reactions, that is, eosinophilic esophagitis,⁹² have been implicated with soy. Soybeans are rich in isoflavones that have been shown to provide a number of health benefits. The presence of isoflavones in soybeans have also raised concern specifically in women with estrogen-sensitive breast cancer, but clinical research has consistently shown no adverse effects on breast cancer risk.⁹³ Soy containing foods have a rich nutrient profile including high quality protein, essential fatty acids, and micronutrients (see **Table 2**).

Table 10
Foods to choose and foods to avoid in wheat free diet

Food Group	Foods to Choose	Foods/Ingredients to Avoid
Meat and other protein-rich foods	The following prepared without wheat or wheat ingredients (fresh, frozen, canned, dried, cured, processed, smoked, or brined): beef, pork, lamb, other meats, poultry, fish, seafood, nut, nut butters, seeds, beans, tofu, cheese, eggs	The following prepared with wheat or wheat ingredients (battered, breaded, bread crumbed, floured, cooked in fryer shared with wheat, or wheat containing): beef, pork, lamb, other meats, poultry, fish, seafood, meatloaf, lasagna, sauces, marinades, seitan, haggis
Dairy	The following (fresh, UHT, dried, condensed, or evaporated): cow, goat, and sheep milks, fresh and soured cream, buttermilk, crème fraîche	Milk with added fiber, artificial cream, yogurt or fromage frais containing muesli or cereals
Grains	Grits, corn, corn flour, corn starch, rice, rice flour, arrowroot, amaranth, buckwheat, millet, teff, quinoa, sorghum, soya flour, potato flour, potato starch, modified starch, gram flour, gluten-free oats, gluten-free bread, gluten-free crackers, gluten-free pasta, gluten-free breakfast cereals, gluten-free stuffing mix	Wheat, wheat bran, wheat germ, wheat starch, bulgur wheat, durum wheat, semolina, couscous, barley, malt, malted barley, rye, triticale, kamut, spelt, farro, Freekeh, einkorn, bread, pastry, spaghetti, macaroni, other pastas, oats not labeled gluten free
Fruits	Pure fruits (fresh, frozen, canned, pureed, juiced, and dried)	Fruits prepared or processed with wheat
Vegetables	Pure vegetables (fresh, frozen, canned, pureed, and dried)	Vegetables prepared in batter, bread, bread crumb, flour, or cooked in fryer shared with wheat; that is, potato croquettes
Fats/oils	Butter, margarine, lard, cooking oils, ghee, low-fat spread	Shared oils with wheat
Desserts/other	Plain potato crisps/chips, homemade popcorn, gluten-free baked goods	Ice cream cones and wafers, thickened liquids, baked goods snacks made from wheat, rye, barley and oats, pretzels
Ingredients	Gelatin, bicarbonate of soda, cream of tartar, yeast, artificial sweeteners, Tomato and garlic puree, individual herbs and spices, vinegars, mixed herbs and spices, ground pepper	Wheat starch, wheat protein isolate, hydrolyzed wheat protein, wheat germ oil, cereal extract, vital wheat gluten

Dietary management of soy and other legume allergies

Many foods contain similar nutrients as those found in soy, so the avoidance of soy alone rarely compromises the nutritional quality of the diet, but because soy is often an ingredient in many processed foods, this may limit food choices for individuals with food allergies (**Table 11**). Asian countries have included fermented and

Table 11 Foods to choose and foods to avoid in soy free diet		
Food Group	Foods to Choose	Foods/Ingredients to Avoid
Meat and other protein rich foods	The following prepared without soy or soy ingredients (fresh, frozen, canned, dried, cured, processed, smoked, or brined): beef, pork, lamb, other meats, poultry, fish, seafood, nut, nut butters, seeds, no soy beans, cheese, eggs	Tofu, tempeh, texturized vegetable protein, Koyadofu
Dairy alternatives	The following prepared without soy or soy products: seed, tree nut and nonsoy legume-based cheeses, yogurts, ice creams and beverages	The following prepared with soy or soy ingredients: cheese, yogurt, ice cream, beverages
Grains	The following prepared without soy or soy ingredients: breads, baked goods (brownies, cakes, cookies, muffins, scones), cereals, crackers, enriched grains, whole grains, noodles, pasta, pancakes, rolls, waffles	The following prepared with soy or soy ingredients: breads baked goods (brownies, cakes, cookies, muffins, scones), cereals, crackers, enriched grains, whole grains, noodles, pasta, pancakes, rice, rolls, waffles, soy grits.
Fats/oils	The following prepared without soy or soy ingredients: Butter, cream, margarine, oils, gravies, sauces and salad dressings, vegan mayonnaise substitutes	Cold pressed or expeller pressed or extruded or unrefined soy oil.
Desserts/other	The following prepared without soy or soy ingredients: cakes, cookies, ice cream, popsicles, pudding, frosting, buttercream	The following prepared with soy or soy ingredients: cakes, cookies, ice cream, popsicles, pudding, frosting, buttercream
Ingredients	Gelatin, herbs, pepper, spices	Natto, miso, hydrolyzed plant protein, soy sauce, soybean (curds or granules), soy protein (concentrate or isolate), Worcestershire sauce, soy sprouts, tamari, okara, soy albumin

unfermented soy foods into their cuisine for centuries, but the consumption of soy foods has increased in the United States and many Western countries over the past 25 years.⁹⁴ Unfermented soy foods include tofu, soy oil, soy flour, and soy milk; fermented soybean products are available as miso, okara, soy sauce, tempeh, or natto. Refined soybean oil is exempt from labeling in the United States because any residual trace amounts of protein that might be in soybean oil have been shown not to cause reactions in soy protein-sensitive individuals.⁹⁵ Lecithin derived from soybeans is present in a wide variety of foods in the form of an emulsifier, stabilizer, or releasing agent and does require labeling under the Food Allergen Labeling And Consumer Protection Act (<https://www.fda.gov/food/food-allergensgluten-free-guidance-documents-regulatory-information/food-allergen-labeling-and-consumer-protection-act-2004-questions-and-answers>). Many health care providers have allowed selected patients

to safely consume soy lecithin. Studies have identified the presence of IgE binding proteins in soy lecithin.^{96,97} However, the proteins present have little antigenicity and food products would generally not contain sufficient soy protein residues to provoke allergic reactions in the majority of consumers allergic to soy (<https://farrp.unl.edu/soy-lecithin>). Gholmie and colleagues⁹⁸ performed a double-blind cross-over study and found the vast majority of those with non-IgE-mediated soy allergy could safely include soy lecithin in the diet.

Most vegetarian and vegan foods use soy as the main source of protein and warrant careful consideration for macronutrient and micronutrient intake. Infants and children following a vegan diet with food allergy need to be carefully monitored specifically for protein intake, as well as for micronutrient deficiencies.⁹⁹ As with all foods, soy foods should be considered part of a varied diet.

Legumes may elicit mild to life-threatening allergenic symptoms. Allergens of peanut and soybean are the most well-known and characterized but other leguminous crops such as lentil, chickpea, beans, peas, mung bean, red gram (pigeon pea), and black gram have been implicated in allergenic reactions.¹⁰⁰ In various countries, the comparative prevalence of allergies to various legumes is variable with allergies to lentils common in Spain and to chickpeas, lentils, and black gram in India.¹⁰¹ Although good comparative studies have not been done in the United States, peanut is surely the most common allergenic legume in the United States, followed by soybean.

Individuals allergic to a single legume often display positive skin prick tests or IgE binding to other legumes that they can safely ingest.^{102,103} Serologic cross-sensitization between members of the legume family (Leguminosae) is observed frequently; however, the clinical symptomatology is documented to be rare. A major soybean allergen, Gly m 4, is cross-reactive with birch pollen allergen, Bet v 1. Cross-reactivity occurs owing to proteins in 1 substance being similar to proteins in another substance and can occur between one food and another or between pollens and food. It is estimated that 10% of patients allergic to birch pollen also have a soy allergy, typically in the form of an oral allergy syndrome. Individuals with birch pollen and soy allergies may have more severe reactions with the intake of large amounts of soy foods, even if processed soy-containing foods are usually well-tolerated.^{104,105}

Key points regarding soy allergy

- Many processed foods contain soy, making a soy elimination diet difficult.
- Soy protein ingredients can be found in some cereals, crackers, canned tuna fish, or even peanut butter.
- Soy lecithin is tolerated by most individuals who are allergic to soy and is not typically avoided on a soy elimination diet.
- Refined soybean oil is exempt from labeling in the United States. Most soybean oil manufactured in the United States and added to food products is highly refined. Avoidance of soy lecithin and soy oil in those with soy allergies are not advised.

Seafood Allergies

Allergy to seafood includes both fish and shellfish. Cartilaginous fish such as shark, ray, skate, and swordfish rarely provoke fish allergy, which is most often triggered by bony finned fish.^{106,107} Fish allergy most often involves sensitization to the muscle protein β parvalbumin, although other allergens may be relevant in tropical fish species or in raw fish.^{108–114} The prevalence of challenge-confirmed allergy ranges from 0% to 0.3%, with high levels reported in the Philippines and Norway.^{106,115,116} Sensitization

usually occurs in childhood, with anaphylaxis more likely to be reported in children.^{117–119} Resolution of fish allergy was considered to be rare, although 1 study reported that 74% of patients with a fish allergy developed tolerance to at least 1 fish species.¹²⁰ Fish and other seafood is also a trigger of non-IgE-mediated food allergies such as food protein-induced enterocolitis syndrome.^{121,122} Differential diagnoses for fish allergy include reactions owing to the consumption of raw or lightly cooked fish contaminated with *L3 Anisakis* spp. larvae,¹²³ and reactions to fish can also be caused by the breakdown of fish histidine into histamine by marine bacteria in the flesh of caught fish, known as scombroid poisoning.¹²⁴

Edible shellfish include crustaceans (crayfish, lobster, crab, and prawns) and mollusks (oyster, mussel, clam, scallop, octopus, squid, and edible snails).¹⁰⁷ Around 2% of the world's population is affected by a shellfish allergy, with challenge-confirmed allergy reported in up to 0.9% of individuals.^{117,125} Shellfish allergy often presents in adult life, with crustaceans rather than mollusks being the most common shellfish involved.^{126,127} The primary shellfish allergen is tropomyosin, which is both water soluble and heat stable, but other allergens may be relevant in different species.¹⁰⁷ The lack of similarity between fish and shellfish allergens usually means cross-reactivity is unlikely, although co-sensitization can also be a potential cause of scombroid poisoning.^{128,129}

Dietary management of fish and seafood allergy

The avoidance of fish and/or shellfish may seem to be easy; however, both fish and shellfish allergens are heat stable and fish allergens can also be aerosolized. Thus, cooking vapors or foods cooked in oil or stock contaminated with fish or shellfish may provoke symptoms.^{130,131} Seafood can also cause reactions owing to its presence as a minor ingredient, such as in prawn crackers, fish-derived gelatin, and Worcestershire sauce as examples. Health products such as fish oil supplements also need to be avoided because they have been known to provoke reactions.¹³² Proper avoidance of seafood and substitutions are noted in [Table 12](#). Seafood plays a valuable role in diet diversity and contributes to optimal nutrition owing to its rich nutrient composition, which includes omega-3 fatty acids, vitamins D, riboflavin (B₂), calcium, phosphorous, iron, zinc, magnesium, and potassium. However, those with seafood allergies can optimize nutrition with alternative sources of alpha linolenic acid and docosahexaenoic acid, as noted in [Table 13](#).

Key points regarding fish and seafood allergy

1. Fish allergy usually starts in childhood, whereas allergy to shellfish is often an adult-onset condition.
2. The allergens in fish and shellfish are different; allergy to one does not automatically require the avoidance of all seafood.
3. Crustaceans are more frequent triggers of shellfish allergy than mollusks.
4. Seafood allergens are heat stable and can provoke reactions owing to aerosolization.
6. Seafood is an important part of a diverse diet and provides important nutrients, especially omega-3 fatty acids and iodine.

Peanuts, Tree Nuts, and Seeds

Nut and seed allergies are typically severe and lifelong.^{133–135} Nut is a culinary term that describes any large, oily kernel within a shell used for food.¹³⁶ Tree nut definitions vary worldwide, but commonly include almond, Brazil nut, cashew, hazelnut, macadamia, pecan, pistachio, and walnut. In the United States, beechnut, butternut,

Table 12
Foods to choose and foods to avoid in seafood free diet

Food Group	Foods to Choose	Foods/Ingredients to Avoid
Meat and other protein-rich foods	The following (fresh, frozen, canned, dried, cured, processed, smoked, or brined): beef, pork, lamb, other meats, poultry, nut, nut butters, seeds, beans, tofu, cheese, eggs	Tuna, anchovies, bass, catfish, cod, flounder, grouper, haddock, hake, halibut, herring, mahi mahi, perch, pike, pollock, salmon, scrod, sole, snapper, swordfish, tilapia, trout, barnacle, crab, crawfish, krill, lobster, prawns, shrimp, abalone, clams, cockle, cuttlefish, limpet, mussels, octopus, oysters, periwinkle, sea cucumber, sea urchin, scallops, snails, squid, whelk, fish sticks, and items cooked in a shared fryer with seafood
Dairy	The following (fresh, UHT, dried, condensed, or evaporated): cow, goat, sheep, and other animal milks (camel, buffalo), butter, buttermilk, cheese, cream, creme fraiche curds, custard, ghee, half and half, ice cream, milk fat, milk protein, pudding, sour cream, yogurt, cottage cheese	
Grains	Wheat, bread, pastry, bulgar wheat, spaghetti, macaroni, other pasta, durum wheat, wheat bran, wheat germ, wheat starch, semolina, couscous, barley, malt, malted barley, rye, triticale, kamut, spelt, oats, farro, Freekeh, einkorn	
Fruits	All fruits (fresh, frozen, canned, pureed, juiced, and dried)	
Vegetables	All vegetables (fresh, frozen, canned, pureed, juiced, and dried)	Vegetables prepared in shared fryers with seafood.
Fats/oils	Butter, margarine, lard, cooking oils, ghee, low fat spread	Fish oil
Desserts/other	All baked goods	Any products prepared in a shared fryer with seafood
Ingredients	Bicarbonate of soda, cream of tartar, yeast, artificial sweeteners, individual herbs and spices, vinegars, mixed herbs and spices, ground pepper	Worcestershire sauce, imitation or artificial fish or shellfish, caponata, Caesar salad or Caesar dressing, bouillabaisse, barbecue sauce, surimi, seafood flavoring, glucosamine, cuttlefish ink, fish gelatin

Table 13 Alternative food sources of alpha linolenic acid and docosahexaenoic acid			
Category (Serving Size)	Food	Alpha Linolenic Acid (g)	Docosahexaenoic Acid (g)
Seeds (1 tbsp)	Flaxseed	2.35	
	Chia	2.53	
Nuts (1 ounce)	Black walnuts	0.76	
	English walnuts	2.57	
Oils (1 tbsp)	Flaxseed	7.26	
	Soybean	0.92	
	Canola	1.28	
Legumes (1/2 c prepared)	Edamame	0.28	
	Refried beans, canned, vegetarian	0.21	
	Kidney beans	0.1	
Other	1 whole omega-3 enriched egg	.34	.75–2.5

chestnut, chinquapin, coconut, ginkgo, hickory nut, lychees, and shea nut are also included; however, these nuts do not commonly elicit reactions.¹³⁶

Seed allergies are an emerging issue in many countries, with sesame most common. Reactions to linseed (flaxseed), pumpkin, poppy, mustard, and sunflower seeds have also occurred.^{137,138} Sesame seed is considered a major allergen in Canada, Australia, and Europe, and the US Food and Drug Administration is considering adding it to its list of major allergens.¹³⁹ For food labeling purposes, pine nuts are considered a seed in Europe, but a nut in North America.

The prevalence rates of nut and seed allergies vary between countries, with peanut allergy affecting up to 3.0%,^{140–142} tree nut allergy up to 3.0%^{143,144} and sesame allergy 0.1% to 0.2%. Other seed allergies seem to be rarer.^{142,145–147} Identifying seeds on labels can be difficult because they are often included as seasonings or spices. Nuts and seeds are important sources of nutrients, particularly for the emerging vegetarian/vegan diets in patients with food allergies.⁹⁹

Dietary management and treatment of nut and seed allergies

Affected children usually have an allergy to the peanut or a single tree nut early in life and may develop multiple nut and seed allergies over time.^{44,148} Table 14 provides a list of safe foods to choose and avoid if peanut or tree nuts are eliminated. In the United States, refined peanut oil is considered safe for those with peanut allergy, but unrefined peanut oil should be avoided. The EU recommends the avoidance of all peanut oils. Sesame oil is largely available unrefined and is not safe for individuals allergic to sesame.

The Pronuts study recently reported that 60% of children with nut or seed allergy had more than 1 other nut or seed allergy.¹⁴⁹ Up to 40% of those with peanut allergy have 1 or more tree nut allergy^{144,150} and 25% have a sesame allergy.¹⁵¹ For those with a tree nut allergy, up to 30% have 1 or more additional tree nut allergy.^{144,150} Tree nut co-allergy is most commonly reported between the walnut and the pecan (Juglandaceae family) and the cashew and the pistachio (Anacardiaceae family).^{144,149,152–154} It is becoming more common to identify tolerated nuts and include

Table 14**Foods to choose and foods to avoid in peanut and tree nut free diet**

Food Group	Foods to Choose	Foods/Ingredients to Avoid
Meat and other protein-rich foods	The following (fresh, frozen, canned, dried, cured, processed, smoked, or brined): beef, pork, lamb, other meats, poultry, fish, seafood, seeds, beans, tofu, cheese, eggs	Nuts and nut butters
Dairy	The following (fresh, UHT, dried, condensed, or evaporated): cow, goat, sheep, and other animal milks (camel, buffalo), butter, buttermilk, cheese, cream, creme fraiche curds, custard, ghee, half and half, ice cream, milk fat, milk protein, pudding, sour cream, yogurt, cottage cheese	Flavored cheese, yogurts with toppings
Grains	Wheat, bread, pastry, bulgar wheat, spaghetti, macaroni, other pasta, durum wheat, wheat bran, wheat germ, wheat starch, semolina, couscous, barley, malt, malted barley, rye, triticale, kamut, spelt, oats not labeled gluten-free, farro, Freekeh, einkorn,	Muesli, granola, breakfast cereals, cereal bars
Fruits	All fruits (fresh, frozen, canned, pureed, juiced, and dried)	Fruits prepared or processed with nuts
Vegetables	All vegetables (fresh, frozen, canned, pureed, juiced, and dried)	Vegetables prepared or processed with nuts
Fats/oils	Butter, margarine, lard, cooking oils, ghee, low fat spread	Cold-pressed, expelled or extruded peanut oil, arachis oil
Desserts/other	Baked goods without peanut or tree nut ingredients	Nougat, fudge, Christmas cakes and puddings, fruit cake icing, baklava (Greek pastry), nut-filled chocolates, praline, marzipan, satay sauce, pesto, Asian and Indian foods

(continued on next page)

Table 14 (continued)		
Food Group	Foods to Choose	Foods/Ingredients to Avoid
Ingredients	Bicarbonate of soda, cream of tartar, yeast, artificial sweeteners, individual herbs and spices, vinegars, mixed herbs and spices, ground pepper,	Lupin, peanut flour, artificial nuts, beer nuts, almond, beechnut, black walnut hull extract, brazil nut, butternut, cashew, chestnut, chinquapin nut, coconut, filbert/hazelnut, gianduja, ginkgo nut, hickory nut, litchi/lichee/lychee nut, macadamia nut, marzipan/ almond paste, nangai nut, natural nut extract, nut butters, nut distillates/alcoholic extracts, nut meal, nut meat, nut milk, nut oils, nut paste, nut pieces, pecan, pesto, pili nut, pine nut, pistachio, praline, shea nut, walnut, walnut hull extract.

them in the diet. The proposed benefits and negative considerations of a more liberal approach are summarized in [Table 15](#).

Oral immunotherapy for peanut allergy (Palforzia) has been approved by the US Food and Drug Administration¹⁵⁵ to be used with avoidance for those with peanut allergies. Oral immunotherapy is not a cure and has risks (adverse reactions, increased risk for eosinophilic esophagitis, and cost of treatment) that must be weighed against the benefits (increased threshold for reactions, improved quality of life, and reduced anxiety).^{156,157} Evidence and expert consensus support introducing peanut in infancy to prevent peanut allergy.^{158,159} Caregivers may need assistance to safely introduce peanuts to nonallergic children in households with nut allergic children.

Table 15 Proposed benefits and negative considerations of blanket nut avoidance	
Proposed Benefits	Negative Considerations
Improved quality of life owing to less restrictive eating and inclusion of nuts that may have important social or cultural significance.	Diagnostic burden of potentially multiple oral food challenges to determine allergy/ tolerance to each nut.
Inclusion of tolerated nuts may halt the progression of multiple nut allergies or facilitate development of cross-tolerance to the index allergic nut	Including multiple nuts in the diet of young children can be challenging owing to choking concerns, taste and texture aversions.
Nuts are a good source of protein and iron, particularly if meat and eggs are excluded from the diet such as those on a vegan diet or with multiple food allergies.	There are no clear guidelines regarding how much and how often nuts should be included.
	Increased burden of managing cross-contamination and labeling issues to identify individual tree nuts on food labels in many countries
	Lack of data regarding potential reactions owing to more liberal approach to nut restriction/eating.

Key points regarding peanut, tree nut and seed allergy

- Blanket avoidance of all nuts or seeds is no longer recommended. Rather, the inclusion of tolerated nuts and seeds should be guided by the allergy-focused history and appropriate allergy testing within an allergy team and ideally supervised by a dietitian.
- Oral immunotherapy for peanut allergy is not a cure, but can decrease the risk of severe reactions.
- In the United States, refined peanut oil is considered to be safe for those with peanut allergy, but unrefined peanut oil should be avoided. The EU recommends the avoidance of refined and unrefined peanut oil stating “However, the risk of severe adverse reactions to highly refined peanut oils seems to be low, although it cannot be ruled out in every highly sensitive peanut allergic individual.”¹⁶⁰ Sesame oil is largely available unrefined and is not safe for sesame allergic individuals.

LIFESTYLE ISSUES

Cross-Contact

Cross-contact happens when one food meets another food. This contact results in a food containing small amounts of another food. Although this amount can be minuscule, it may cause an allergic reaction in children with food allergies.

Ways patients can avoid cross-contact include

- Use kitchen equipment that has been washed well with soap and water.
- Always wash hands with soap and water and dry with a hand towel (paper or fabric) before touching other foods or switching between kitchen utensils. Antibacterial gels will not remove food allergens.
- Store allergy-safe foods covered and away from other foods that may splatter or spill.
- Thoroughly wash counters and tables with soap or household cleaner and water after preparing meals.
- Limit the sharing of food, drinks, and utensils. Teach children not to share these items when at school or with friends.
- Encourage hand and face washing for all family members after meals, especially when allergens are present in the meal, to avoid topical exposure with hugs and kisses.
- When shopping, avoid bulk bins, salad or soup or buffet bars, and the deli counter.

Eating away from Home

Banning allergens from public places is controversial; it is supported by limited evidence and may provide a false sense of security. Allergens can be removed using common cleaning methods.¹⁶¹ The most common lifestyle issues to address in those with food allergies include eating in restaurants and traveling and have been discussed in detail by Venter and colleagues.¹⁶²

Restaurants

The management of food allergy in restaurants can be challenging. Tips for food allergic patients eating out in restaurants include the following.

- Check the restaurant’s website for allergen information before visiting. Consider calling ahead to inform staff of food allergies.

- Once at the restaurant, always tell restaurant staff very clearly about which food allergens require avoidance. Ask about ingredients and food preparation methods.
- Recommend using a “chef card” or “translation card” to help to assist with communication. These can be found at www.foodallergy.org
- Avoid peak times, such as lunch and dinner rushes, when staff are more distracted.
- Be aware of cross-contact. Avoid restaurants that are high risk for cross-contact, such as buffets or all-you-can-eat restaurants. Avoid fried foods if fryers are used for multiple menu items (chicken nuggets, cheese sticks, popcorn shrimp). Ask for meat and vegetables to be wrapped in foil before being placed on the grill. Ask line servers to change their gloves.
- In case of any doubt, ask the waiter or ideally the chef to double check. Do not hesitate to send food back.
- Have a backup plan by having an allergy friendly snack available.

Travel

Travel raises issues regarding food avoidance and choosing suitable foods. Airline, railway, and nautical policies around the world differ and the safest option may be to take allergen-safe foods along and avoid all foods provided by the airline. For example, food allergen labeling of nonpackaged foods served on airplanes is not currently enforced for flights departing from the United States.¹⁶³ EU food labeling laws,¹⁶⁴ however, dictate that allergens must either be listed on the packaging, menu, recipe, or ticket or be available from a crew member for flights leaving from the EU or UK. In case the family opts to consume foods provided by their traveling option, it is advisable to be aware of the national allergen policies and travel method specific policies. It is important to contact the carrier beforehand about any food allergen-related restrictions. Verify information upon check-in; boarding the train, aircraft, or boat; and once again when the food is served. Ask to be provided with an ingredient list if possible. Always travel with the required emergency medication at hand. It may be worth checking with the airline or carrier about the availability of emergency medication on board the aircraft, train, or boat as well.

SUMMARY

Food allergy is increasing worldwide. There are several major food allergens; however, any food can potentially become an allergen and we should still be wary of novel allergens. Recently, the move toward individualized management of food allergy has led to subtlety in management strategies such as encouraging intake of baked egg and baked milk when tolerated and inclusion of tolerated tree nuts and fish, rather than elimination of complete food groups. This has the advantage of less limited diets and improved quality of life.

Important factors to address during a nutritional consultation include allergen avoidance and ensuring the diet is nutritionally balanced. Allergen avoidance requires label reading skills and an understanding of food allergy labeling laws, which differ among countries or regions. Other avoidance education needs are understanding cross-contact, how to eat away from home, and how to travel. The risk of accidental exposure to allergens can be mitigated through adequate knowledge and suitable precautions taken by both patients and caregivers.

It is important to recognize and support the patients' nutritional requirements and quality of life, and this is particularly important for infants and young children where appropriate growth and development of normal feeding skills should be assessed

as part of ongoing nutritional management. Given the risks of inadequate allergen elimination diets, dietary guidance is vital as the prevalence of allergies to the most common foods, and allergies to multiple foods is increasing. Moving forward, the value of a dietitian on the food allergy clinic team is immeasurable as the intricacy of management is ever evolving and stretches beyond simply avoiding the allergen.³³

CLINICS CARE POINTS

- Comprehensive and individualized avoidance education is a safety necessity.
- Appropriate substitutions aid in the management of food allergy.
- Nutritional complete diets ensure adequate nutrition for optimal growth.
- Reading food allergen labels is a necessary and fundamental skill of allergy management.
- Recently, the move toward individualized management of food allergy has led to subtlety in management strategies such as encouraging intake of baked egg and baked milk when tolerated and inclusion of tolerated tree nuts and fish, rather than the elimination of complete food groups.
- Lifestyle factors vary among individuals and play an integral part in allergy management.
- Dietary input from a registered dietitian as part of a multidisciplinary team improves both growth parameters and nutritional biomarkers and supports patient self-efficacy.

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