

Food allergies in children affect nutrient intake and growth

LYNN CHRISTIE, MS, RD; R. JEAN HINE, PhD, RD; JAMES G. PARKER, MS; WESLEY BURKS, MD

ABSTRACT

Objectives To identify if specific food allergies, elimination diets, or other variables associated with food allergies have an impact on the growth and nutrient intake of children with food allergies.

Design Measurements of height, weight, and body mass index were used to determine potential growth problems. Estimates of energy and nutrient intakes were based on 3-day diet records. A questionnaire was used to determine number of food allergies and other variables.

Subjects Ninety-eight children with food allergies (subjects, mean age 3.7 ± 2.3 years) and 99 children without food allergies (controls, mean age 4.1 ± 2.4 years) participated in this age-matched, consecutive sampling, cross-sectional study.

Statistical analysis performed Cochran-Mantel-Haenszel statistics using general association and Fisher Exact Test, with 2-sided probability, were conducted.

Results Children with two or more food allergies were shorter, based on height-for-age percentiles, than those with one food allergy ($P < .05$). More than 25% of children in both groups consumed less than 67% of the DRI (RDA or AI) for calcium, vitamin D, and vitamin E. More children with cow's milk allergy or multiple food allergies consumed dietary calcium less than age- and gender-specific recommendations compared with children without cow's milk allergy and/or one food allergy. The possibility of consuming a less than recommended intake of calcium and vitamin D in children with food allergy was less if the child received nutrition counseling ($P < .05$) or consumed a safe infant/toddler formula or fortified soy beverage.

Applications/conclusions Children diagnosed with food allergies need an annual nutrition assessment to prevent growth problems or inadequate nutrient intake. Children with milk allergies or multiple food allergies are at greater risk. Nutrition education needs to address how to avoid all forms of the allergen and incorporate alternative nutrient-dense foods. This population would benefit from the development and validation of a medical nutrition therapy protocol. *J Am Diet Assoc.* 2002;102:1648-1651.

Food allergies are unique because there are no pharmaceutical interventions to prevent allergic reactions. Avoidance of the food allergen source by carefully following an elimination diet is the only treatment. Following a specific food elimination diet is becoming more challenging because food manufacturers use many of the common food allergens in their products. Six percent to eight percent of children develop food allergies within the first 3 years of life (1), which is a critical period of growth. Ninety percent of the food allergies in children involve cow's milk, egg, peanut, wheat, soy, tree nuts, or fish. Multiple food allergies are rare; more than 80% of children with food allergies react to only one or two allergens (2,3). Fortunately, most children outgrow their allergies to milk, egg, wheat, and soy by 3 to 5 years of age (1,4), and 20% of infants with peanut allergy will eventually tolerate peanuts (5,6). Because some foods containing food allergens are rich in essential nutrients, monitoring dietary intake of children with food allergies is important to prevent poor nutrient intake, especially poor intake arising from unnecessary food avoidance (7).

Case reports describe vitamin and mineral deficiencies (8), kwashiorkor (9), and failure to thrive (10) as consequences of inappropriate exclusion diets and inadequate follow-up after diagnosis of food allergies. Parental beliefs that food allergies cause health and behavior problems can lead to food elimination diets so severe that children develop failure to thrive (11). Therefore, eliminating foods or food groups, based on actual or perceived allergies, may lead to deficient nutrient intake and poor growth. The purpose of this study was to identify types of food allergies, dietary restrictions, and other variables associated with food allergies that may affect the dietary intake and growth of children with food allergies. This information will provide insight into potential areas of concern that can be addressed through dietary intervention.

L. Christie is a clinical coordinator and W. Burks is a professor, both with the Department of Pediatric Allergy and Immunology, University of Arkansas Medical Sciences and Arkansas Children's Hospital, Little Rock. R. J. Hine, is a professor in the Department of Dietetics and Nutrition, University of Arkansas Medical Sciences, Little Rock. J. G. Parker is a senior analyst in the Biostatistics Section, University of Arkansas for Medical Sciences.

Address correspondence to: Lynn Christie, MS, RD, Clinical Coordinator, Department of Pediatric Allergy and Immunology, Arkansas Children's Hospital, 1120 Marshall St, Slot 512-13, Little Rock, AR, 72202. Email: christielynn@uams.edu

METHODS

Subjects

This research was a cross-sectional study using consecutive sampling of children (age 1 month to 10 years) diagnosed with food allergies and age-matched control subjects without food allergies. Recruitment occurred in Allergy and General Pediatric Clinics at Arkansas Children's Hospital. Children were diagnosed with food allergies after a positive skin prick test, food specific immunoglobulin E (IgE), or food challenge, and had been following a food elimination diet. Atopic diseases (ie, atopic dermatitis, asthma, environmental allergies, allergic rhinitis) were part of the inclusion criteria. Children were excluded if they had taken more than one course of oral steroids/year or had other chronic diseases. Control subjects met the same inclusion and exclusion criteria except they did not have food allergies.

A registered dietitian (RD) completed a questionnaire addressing demographics, type of food allergies, and if the family had received any nutrition counseling for this child. The University of Arkansas Medical Sciences Human Research Advisory Committee approved the protocol. Written informed consent was obtained from each child's parent or guardian, and assent was obtained from the children.

Anthropometric Measurements

Clinical staff measured length or height and weight, and body mass index (BMI) was calculated for all subjects (12). Anthropometric measurements were compared with the Centers for Disease Control-National Center for Health Statistics Growth Charts (13). BMI, height-for-age, and weight-for-age growth standards were placed into one of three categories: less than 25th percentile to identify potential undernutrition, 25th to 75th percentile to identify adequate nutrition, and more than 75th percentile to identify potential overnutrition. The association of food allergy with anthropometric measurements was evaluated by Cochran-Mantel-Haenszel Statistics using general association.

Dietary Intake Assessment

An RD gave parents and subjects detailed verbal instructions about how to complete dietary intake records. Picture models of portion sizes were used to help caretakers estimate food consumption, and written instructions were reviewed regarding how to record intake for 2 consecutive weekdays and 1 weekend day. Each completed dietary record was verified to resolve any omissions or ambiguities. The record was analyzed using the Nutritionist V Diet Analysis (version 2.1, First Data Bank, San Bruno, Calif, 1999.) Estimated energy and protein needs were based on weight and age using the 10th edition of the Recommended Dietary Allowances (10th ed. RDA) (14). Intakes of vitamins C, A, D, and E, folate, calcium, phosphorus, iron, and zinc were compared with the Dietary Reference Intake (DRI) for age (15-18). The DRI publications suggest that the Recommended Dietary Allowance (RDA) and Adequate Intake (AI) be used as a goal for the nutrient intake of healthy individuals. Because there is not an Estimated Average Requirement for all nutrients of interest, the RDA and AI were the DRI values used in this study for consistency to evaluate less than standard intakes. Dietary intake of a nutrient less than 67% of the RDA (10th edition, 1989) or DRI suggests that consumption of that specific nutrient needs to be improved. This information cannot, however, be used to assess the prevalence

Table 1
Height-for-age based on presence of food allergies

	Percentile					
	25th ^a		25th-75th		>75th	
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
Allergic to 1 food ^b (n=32)	5	16	16	50	11	34**
Allergic to ≥2 foods ^b (n=63)	22	35*	33	52	8	13
Children with food allergy (n=95)	27	28	49	52	19	20
Control subjects (n=96)	16	17	54	56	26	27

^aPercentile based on height-for-age (3-10 years of age) or length-for-age (0-2 years of age) using Centers for Disease Control—National Center for Health Statistics Growth Charts (reference 13).

^b3 X 2 table identified a significance $P < .05$.

* $P < .05$, based on 2 X 2 tables.

** $P < .01$, based on 2 X 2 tables.

of inadequacy (19). The Fisher Exact Test with 2-sided probability was used to compare the proportion of children with food allergies receiving less than 100% and less than 67% of the RDA/DRI to the control children. Results are reported for significance levels of $P \leq .05$. Statistical analyses were performed using the SAS System for Windows (version 8, 1999, SAS Institute Inc, Cary, NC).

RESULTS

The study included 197 children. Of these, 98 (mean age 3.7 ± 2.3 years) had food allergies and 99 (mean age 4.1 ± 2.4 years) served as healthy controls. Two thirds of the food allergy group (n=62) had atopic dermatitis. A large number of children with two or more food allergies were categorized as less than 25th percentile height-for-age compared with those with one food allergy ($P < .05$) (Table 1). Overall, more children with food allergies were less than 25th percentile height-for-age than control subjects. The distribution of height-for-age among the children with food allergies was normal.

Peanut allergy is the most common single food allergy. Among study children with a single food allergy (n=33), 72% (n=24) had a peanut allergy. If a child had two food allergies, the most predominant pairs were egg and peanut or egg and milk. Among study children with two food allergies (n=27), 37% (n=15) were allergic to egg and peanut and 30% (n=8) were allergic to egg and milk. For those allergic to three foods (n=18), 44% (n=8) were allergic to egg, milk, and peanut.

Dietary intake records were returned by 66% (n=65) of subjects with food allergies and 64% (n=63) of the controls. More than 25% of children in both groups had intakes less than 67% of the DRI for calcium, vitamin D, and vitamin E (Table 2). The number of children who did not meet 67% of the RDA/DRI recommendations for selected nutrients are listed according to presence or absence of food allergies, respectively: energy (7 vs 16), phosphorus (0 vs 3), iron (7 vs 10), zinc (4 vs 3), vitamin C (1 vs 2), folate (10 vs 14), and vitamin A (8 vs 8).

Less than age- and gender-specific recommendations for calcium intake was common not only among those with cow's milk allergy, but was twice as high among those with multiple (≥ 2) food allergies (Table 2). An important finding of our study was that among children allergic to cow's milk (n=11) 91% (n=10) who drank a safe infant/toddler formula or fortified soy beverage met their DRIs for calcium and vitamin D. Among

Table 2

Comparison of calcium, vitamin D, and vitamin E intakes by children with milk allergies vs other food allergies and according to nutrition counseling

Group	Calcium ^a				Vitamin D				Vitamin E			
	<100%		<67%		<100%		<67%		<100%		<67%	
	n	%	n	%	n	%	n	%	n	%	n	%
Food allergy (n=65)	27	42	16	25	41	63	27	41	51	78*	44	67
Controls (n=63)	29	46	16	25	44	70	34	54	58	92	56	88
Single food allergy (n=20)	5	25	3	15	14	70	9	45	18	90	15	75
Multiple food allergies (n=45)	22	49	14	31	27	60	18	40	33	73	29	64
Cow's milk allergy (n=26)	15	58**	10	38	14	54	11	42	16	62***	14	53
Other food allergies (n=39)	12	31	7	18	27	69	16	41	35	90	30	77
Food allergies (with nutrition counseling) (n=34)	10	29****	5	15****	18	53	10	29****	25	74	20	58
Food allergies (without nutrition counseling) (n=31)	17	55	12	39	23	74	17	55	26	84	24	77

^aMean intake <100% and <67% of Dietary Reference Intake (references 15,17). Using Adequate Intakes for calcium and vitamin D, Recommended Dietary Allowances for vitamin E.

* $P < .05$ comparing children with food allergy to controls.

** $P < .05$ comparing children with and without cow's milk allergy.

*** $P < .01$ comparing children with and without cow's milk allergy.

**** $P < .05$ comparing children with and without nutrition counseling.

children with food allergies, the number of children not meeting 67% of the DRI for calcium and vitamin D was statistically higher ($P < .05$) for those who had not received nutrition counseling compared with those who had (Table 2).

DISCUSSION

An elimination diet is the only available treatment for a child diagnosed with a food allergy. The nutrition complications of elimination diets are poorly defined. The results of this study and those of others (20-22) suggest that food allergies have negative effects on growth and food intake. However, the small sample size suggests cautious interpretation of this data. The only published studies that addressed growth issues evaluated children with cow's milk allergy. A longitudinal study (20) of children with cow's milk food allergy revealed that relative length or height decreased after the onset of food allergy symptoms and that no catch-up growth was observed by 24 months of age. Similarly, Paganus et al (21) and Tiainen et al (22) detected a lower height/age ratio among children with cow's milk food allergy compared with healthy children.

The growth of the subjects with food allergy was less than expected compared with control subjects possibly because the majority were also diagnosed with atopic dermatitis (eczema). Food allergy plays a pathogenic role in approximately one third of children with atopic dermatitis (2,3). This allergic disorder is characterized by chronic inflammatory skin disease that presents with extreme pruritus and erythematous, papulovesicular dermal eruptions in early childhood. Multiple triggers can cause atopic dermatitis to flare, ie, skin irritants such as wool, dry skin, emotional stress, environmental allergens, and food allergens. Atopic dermatitis has also been implicated as a risk factor for delayed growth of children. Several researchers have reported growth impairment in children with atopic dermatitis (23,24) including Patel et al (25), who revealed a pattern of constitutional growth delay, a deceleration of growth during the first 2 years of life, and catch-up growth occurring after the pubertal growth spurt. Inadequate food intake for age has been postulated as a cause of constitutional growth delay (26). The few children in this study with food allergies who

consumed less than 67% of energy goal had normal growth. One limitation of this study is that the growth effects of atopic dermatitis were not separated from those of food allergy. There may be increased nutrient requirements associated with the inflamed and chronic state of atopic dermatitis that may lead to growth problems.

The potential effects of food allergies on growth and nutrient intake are based on the foods one avoids due to food allergies. For example, diminished consumption of cow's milk and wheat due to food allergies affect children's macronutrient and micronutrient intakes. Cow's milk and milk products are the primary source of calcium and vitamin D. Families need counseling about appropriate alternative sources of these major nutrients. By contrast, peanuts, tree nuts, and fish rarely compromise overall diet quality because many other foods contain the same nutrients. Many foods supply the nutrients found in eggs, but eggs are a component of so many processed foods that parents of children with egg allergies need guidance about selection of convenience foods or how to prepare acceptable egg-free foods. Among children with multiple food allergies, problems associated with safety and nutrient adequacy of the child's diet are amplified. Based on our experience in a pediatric allergy specialty clinic, children with multiple food allergies benefit from a nutrition assessment within 1 month of diagnosis and counseling about foods to avoid, and then nutrition follow-up on a 6-month or annual basis. This proactive approach identifies problems early and assists the family with solutions.

Neither group of children in our study consumed enough foods containing sufficient amounts of calcium, vitamin D, and vitamin E to meet recommended goals. Adequate intake of vitamin E protects the cells from oxidative damage and is associated with optimal health later in life. Vitamin D and calcium are associated with reducing the risk of osteoporosis (27).

Children in this study with cow's milk allergy or multiple food allergies are at risk of consuming less than the recommended amount of calcium. Paganus et al (21) and Tiainen et al (22) both followed children with cow's milk allergy (mean age 2.0 years), concluding that the intake of soy or casein hydrolysate-based formula or calcium supplementation was needed to

assure adequate calcium intake. This study demonstrated that almost all of the children with cow's milk allergy who consumed a safe milk-free formula or fortified soy beverage met their calcium and vitamin D needs. These results emphasize the importance of children with cow's milk allergy to continue the use of these safe, fortified beverages on a long-term basis to meet their calcium and vitamin D needs. These data illustrate the difficulty of obtaining sufficient amounts of calcium from foods other than milk. Calcium-fortified juices, breads, and other foods may provide a safe alternative for some children with cow's milk food allergy, but these foods are rarely fortified with vitamin D.

To the best of our knowledge, this study is unique because it suggests there may be a significant improvement of nutrient intake with nutrition counseling. Unfortunately, nutrition counseling in this study was not well defined. Other studies (20-22) confirm this need and recommend nutrition counseling for children requiring any food allergy elimination diet. This information should encourage the development of a pediatric food allergy medical nutrition therapy protocol that promotes professionalism and encourages reimbursement. Qualified RDs can educate individuals and families about how to avoid all forms of the food(s) causing the food allergy, including information about where food allergens are hidden. For example, families using convenience foods may be unaware of the inclusion of eggs in most bakery products or milk in pancake mixes. Nutrition counseling can also address appropriate, nutrient-rich alternatives to food allergens.



APPLICATIONS

- Adequate testing for food allergies is crucial prior to dietary intervention to avoid unnecessary food elimination. Food allergy testing involves skin prick tests and/or radioallergen sorbent tests that identify the presence of immunoglobulin E to specific foods. If a strong history of allergy is consistent with the testing, avoidance of the food would be indicated. Otherwise, food challenges would be an appropriate next step to rule out the foods to which the child may be allergic.
- Children with food allergies benefit from nutrition counseling. These children need a nutrition assessment to identify growth or nutrient intake problems.
- The dietitian should communicate effectively how to avoid all forms of the food allergen, particularly hidden sources in processed foods.
- Preventive nutrition counseling for individuals with food allergies should also incorporate information about nutrient-dense alternative foods.
- A child with two or more food allergies or cow's milk food allergy should continue consuming a fortified, allergen-free formula for as long as the child will accept the product or until the child outgrows the allergy. Fortified foods or supplements may be needed to assure adequate consumption of calcium and vitamin D. Even if a child outgrows an allergy, screening for

calcium intake and vitamin D exposure is important because of potential residual food aversions.

References

1. Bock SA. Prospective appraisal of complaints of adverse reactions to foods in children during the first 3 years of life. *Pediatrics*. 1987;79:683-688.
2. Burks AW, James JM, Heigel A, Wilson G, Wheeler JG, Jones SM, Zuerlein N. Atopic dermatitis and food hypersensitivity reactions. *J Pediatr*. 1998;132:132-136.
3. Sampson HA, McCaskill CM. Food hypersensitivity and atopic dermatitis: evaluation of 113 patients. *J Pediatr*. 1985; 107:669-675.
4. Host A, Halken S. A prospective study of cow milk allergy in Danish infants during the first 3 years of life. *Allergy*. 1990;45:587-596.
5. Hourihane JO'B, Roberts SA, Warner JO. Resolution of peanut allergy: case-control study. *Br Med J*. 1998;316:1271-1275.
6. Skolnick HS, Conover-Walker MK, Koerner CB, Sampson HA, Burks W, Wood RA. The natural history of peanut allergy. *J Allergy Clin Immunol*. 2001;107:367-374.
7. Sicherer SH. Food Allergy: When and how to perform oral food challenges. *Pediatr Allergy Immunol*. 1999;10:226-234.
8. Bierman CW, Shapiro GG, Christie DL, VanArsdel PP, Furukawa CT, Ward BH. Eczema, rickets, and food allergy. *J Allergy Clin Immunol*. 1978;61:119-127.
9. Liu T, Howard RM, Mancini AJ, Weston WL, Paller AS, Drolet BA, Esterly NB, Levy ML, Schachner L, Frieden IJ. Kwashiorkor in the United States: fad diets, perceived and true milk allergy, and nutritional ignorance. *Arch Dermatol*. 2001;137:630-636.
10. Tarnow-Mordi WO, Moss C, Ross K. Failure to thrive owing to inappropriate diet free of gluten and cow's milk. *Br Med J*. 1984;289:1113-1114.
11. Boesler TA, Barry PC, Bock SA. Factitious food allergy and failure to thrive. *Arch Pediatr Adolesc Med*. 1994;148:1150-1155.
12. Lohman T, Roche A, Martorell R. *Anthropometric Standardization Reference Manual*. Champaign, Ill: Human Kinetics Books;1988.
13. Kuczmarski RJ, Ogden CL, Grummer-Strawn LM, Flegal KM, Guo SS, Wei R, Mei Z, Curtin LR, Roche AF, Johnson CL. CDC Growth Charts: United States. Hyattsville, Md: National Center for Health Statistics. 2000. Advanced Data from Vital and Health Statistics No. 314.
14. Food and Nutrition Board. *Recommended Dietary Allowances*. 10th ed. Washington, DC: National Academy Press; 1989.
15. Institute of Medicine. *Dietary Reference Intakes for Calcium, Phosphorus, Magnesium, Vitamin D and Potassium*. Washington, DC: National Academy Press; 1997.
16. Institute of Medicine. *Dietary Reference Intakes for Thiamin, Riboflavin, Niacin, Vitamin B6, Folate, Vitamin B12, Pantothenic Acid, Biotin, and Choline*. Washington, DC: National Academy Press; 1998.
17. Institute of Medicine. Food and Nutrition Board. *Dietary Reference Intakes for Vitamin C, Vitamin E, Selenium, and Carotenoids*. Washington, DC: National Academy Press; 2000.
18. Institute of Medicine. Food and Nutrition Board. *Dietary Reference Intakes for Vitamin A, Vitamin K, Arsenic, Boron, Chromium, Copper, Iodine, Iron, Molybdenum, Nickel, Silicon, Vanadium and Zinc*. Washington, DC: National Academy Press; 2001.
19. Barr SI, Murphy SP, Poos MI. Interpreting and using the dietary reference intakes in dietary assessment of individuals and groups. *J Am Diet Assoc*. 2002;102:780-788.
20. Isolauri E, Siitonen Y, Salo MK, Isolomppi R, Mäkelä K. Elimination diet in cow's milk allergy: Risk for impaired growth in young children. *J Pediatr*. 1998;132:1004-1009.
21. Paganus A, Juntunen-Backman K, Savilahti E. Follow-up of Nutritional status and dietary survey in children with cow's milk allergy. *Acta Paediatr*. 1992;81:518-521.
22. Tialinen JM, Nuutinen OM, Kalavainen MP. Diet and Nutritional status in children with cow's milk allergy. *Eur J Clin Nutr*. 1995;49:605-612.
23. Kristmundsdottir F, David TJ. Growth impairment in children with atopic eczema. *J R Soc Med*. 1987; 80:9-12.
24. Pike MG, Chang CL, Atherton DJ, Carpenter RG, Preece MA. Growth in atopic eczema: a controlled study by questionnaire. *Arch Dis Child*. 1989;64:1566-1569.
25. Patel L, Clayton PE, Addison GM, Price DA, David TJ. Linear growth in prepubertal children with atopic dermatitis. *Arch Dis Child*. 1998;79:169-172.
26. Maggioni A, Lifshitz F. Endocrine Disorders. In: Kessler DB, Dawson P. *Failure to Thrive and Pediatric Undernutrition, A Transdisciplinary Approach*. Baltimore, Md: Paul H. Brookes Publishing Co;1999:255-260.
27. National Research Council. *Diet and Health: Implications for Reducing Chronic Disease*. Washington, DC: National Academy Press;1989.

This research was funded through a grant by the Children's University Medical Group, University of Arkansas Medical Sciences, Little Rock.