

Diet and nutritional status of children with food allergies

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The aim of the present study was to assess the food intakes and nutritional status of children with food allergies following an elimination diet. We conducted a cross sectional study including 96 children (mean age 4.7 ± 2.5 years) with food allergies and 95 paired controls (mean age 4.7 ± 2.7 years) without food allergies. Nutritional status was assessed using measurements of weight and height and Z scores for weight-for-age, height-for-age and weight-for-height. Nutrient intakes assessment was based on a 3-day diet record. Children with food allergies had weight-for-age and height-for-age Z scores lower than controls (0.1 versus 0.6 and 0.2 versus 0.8 respectively). Children with 3 or more food allergies were smaller than those with 2 or less food allergies ($p = 0.04$). A total of 62 children with food allergies and 52 controls completed usable diet records. Energy, protein and calcium intakes were similar in the two groups. Children with food allergies were smaller for their age than controls even when they received similar nutrient intakes. Nutritional evaluation is essential for the follow up of children with food allergies.

**Sophie Flammarion¹, Clarisse Santos¹,
Dominique Guimber², Lyne Jouannic³,
Caroline Thumerelle¹, Frédéric
Gottrand² and Antoine Deschildre¹**

¹Unité de pneumologie et allergologie pédiatriques, département de pédiatrie, hôpital Jeanne de Flandre, CHRU de Lille, France, ²Unité de gastroentérologie et nutrition pédiatriques, département de pédiatrie, hôpital Jeanne de Flandre, CHRU de Lille, France, ³Service de diététique, département de pédiatrie, hôpital Jeanne de Flandre, CHRU de Lille, France

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Dr Antoine Deschildre,
Unité de pneumologie et allergologie pédiatrique,
Hôpital Jeanne de Flandre, Avenue Eugène Avinée,
CHRU de Lille, 59 037 Lille Cedex, France
Tel.: 03 20 44 50 72
Fax: 03 20 44 41 07
E-mail: adeschildre@chru-lille.fr

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The prevalence of food allergies is increasing worldwide and is currently estimated at 4.7% in the French school-aged population (1). Food-induced allergic reactions are responsible for a variety of symptoms involving the skin, gastro-intestinal tract and respiratory tract (2). The main foods responsible for food allergies are cow's milk, eggs and peanuts. Kiwi fruits and tree nuts are also increasingly common allergies in the French paediatric population (1). The only proven therapy for food allergies is the strict removal of the identified food allergens from the diet. This requires careful dietary evaluation and education (3). Therapeutic elimination diets have been shown to reduce the symptoms of food allergies but could be responsible for nutrient deficiencies and failure to thrive, especially if a significant number of foods are avoided (4–6). A few previous studies have reported reduced growth despite normal energy intakes in children with food allergies (7–10). The aim of our study was to assess nutrient intakes and nutritional

status in a group of children with food allergies following an elimination diet.

Methods

Population

This research was a cross-sectional study of children with at least one food allergy referred to the Pediatric Pulmonology and Allergology Unit of Jeanne de Flandre University Hospital in Lille between March and June 2005. Children were included if they had a proven food allergy treated by an elimination diet for at least 4 months, were more than 6 months and <15 yr old, and were following a diversified diet at the time of the study. Exclusion criteria were any other associated chronic diseases, nutritional support (enteral or parenteral) or a history of digestive surgery. Diagnoses of food allergies were based on clinical symptoms of allergies, associated with either positive skin prick tests or

food-specific immunoglobulin E (IgE), or on a positive oral food challenge. Skin prick tests used commercially prepared extracts (Stallergènes®, Anthony, France) or native foods. They were positive for a wheal of at least 3 mm. Specific IgE were dosed with Cap system (Phadia®, Uppsala, Sweden).

Records were taken of the number and type of foods involved. Clinical signs of allergy (asthma, eczema and digestive symptoms) at diagnosis and at the time of study were recorded. Asthma control was assessed at the time of study according to GINA guidelines and classified as controlled or not controlled (partly and uncontrolled levels). Eczema severity at the time of study was classified as controlled, localized skin involvement or severe skin involvement. Inhaled corticosteroid (ICS) and topical steroid treatments received at the time of study were also recorded. ICS doses higher than 400 µg/day of fluticasone were considered as high doses.

The children with food allergies were paired for age and sex with control children with no food allergy. Identical inclusion and exclusion criteria were applied to the controls, except that they had no food allergies and followed no elimination diet.

Nutritional status

Children were weighed wearing light clothes using electronic scales, and their heights were measured. All weights and heights were compared to Sempé reference values for French children (11). Weight-for-age (W/A), height-for-age (H/A) and weight-for-height (W/H) were converted into Z scores.

Nutrient intakes

The daily nutrient intakes were assessed using a 3-day diet record (12). The parents of all the children taking part in the study were contacted by telephone 3 wk prior to consultation. They were asked to fill in a 3-day diet record report in the form of a printed chart sent to them through the mail. The charts included explanations about how to record the food consumed and how to make measurements using common instruments such as graduated bowls, cups, dishes and spoons. Oral instructions were also given to each parent on how to keep accurate records. Each page of the report corresponded to 1 day and was separated in five parts: breakfast, lunch, tea and dinner and snacks. The same dietician reviewed each individual report and checked the quantity of all meals and drinks. The

dietician was experienced in identifying reporting errors and the plausibility of food recording. The portion sizes were estimated using a three-dimensional portion chart instrument including photographs of common foods corresponding to exact quantities. Calculations of energy, proteins, carbohydrates, fat, calcium, phosphorus, iron, magnesium, and vitamins A, D, C and E were all made using Winrest 32® (Paris, France) programme using French foods composition tables and manufacturers' data (13). The nutrient intakes were compared to the recommended dietary intakes for healthy children in France (14). There were no available reference values for carbohydrate and fat intakes.

Statistical analysis

Means and standard deviation (SD) were used to describe the quantitative data. The two groups were compared using Mann–Whitney tests. When the difference was significant, the mean difference and 95% confidence interval (95% CI) were indicated. Fisher tests were used to make proportional comparisons of the children. Results were reported for a significance level of $p < 0.05$. Statistical analyses were performed using the SPSS. 13 (Chicago, Illinois, USA) program for Windows.

Results

We studied 96 children (60 boys and 36 girls) with food allergies whose mean age was 4.7 (SD 2.58). Their mean weight was 17.8 kg (SD 8.3 kg) and their mean height was 103.9 cm (SD 19.5 cm). Among the 96 children with food allergies, 61 (63%) had a history of atopic dermatitis, 38 (40%) had acute urticaria, 66 (69%) had asthma, 32 (33%) had gastrointestinal symptoms (diarrhoea, vomiting, or constipation), 6 (6%) had oral allergic syndrome, and 4 (4%) had rhino conjunctivitis. None had a history of anaphylactic shock. Sixty-three (65%) children had more than one symptom. At the time of study, asthma was controlled for 32 children. Fifty-one children received ICS, with 28 receiving high doses of ICS and 24 receiving combined ICS and long-acting beta2-adrenergics. Thirty-three children had persistent atopic dermatitis, among those seven had severe skin involvement. Thirty children were treated with topical steroids and four with topical tacrolimus. No children had persistent gastrointestinal symptoms at the time of study.

The main foods involved were peanuts for 59 children (61%), eggs for 50 children (52%), cow's milk for 28 children (29%), soybeans for 15

children (15%) and fish for 10 children (10%). Thirty-three children (34%) were allergic to one food only, 22 (23%) to two foods and 41 (43%) children to three foods or more. Among the 96 children with food allergies, 85 (88%) had received nutrition counselling by a trained dietitian at the time of the study, the other 11 children had been counselled by their paediatrician.

The control group included 95 children (59 boys and 36 girls) with a mean age of 4.7 (SD 2.7). Their mean weight was 17.9 kg (SD 6.2 kg) and their mean height was 104.9 cm (SD 19 cm).

Nutritional status

W/A and H/A Z scores of the children with food allergies were lower than those of the children in the control group (mean difference -0.5 , 95% CI $[-0.95; -0.05]$, $p = 0.01$ and mean difference -0.56 , 95% CI $[-1.02; -0.09]$, $p = 0.03$) (Table 1). The mean W/H Z score representing global nutritional status was similar in the two groups. However, although the global nutritional status in both groups was normal, the children with food allergies were smaller than those in the control group. Nine children with food allergies had W/A Z scores < -2 and seven had H/A Z scores < -2 , no control children had W/A Z scores < -2 and two controls only had H/A Z scores < -2 ($p = 0.01$ and $p = 0.03$, respectively) (Table 2).

Children allergic to three foods or more were smaller than children allergic to one or two foods ($p = 0.03$) (Table 2). There was no difference in the W/A and H/A Z scores of children with food allergies depending on the existence of eczema or asthma or gastrointestinal symptoms. Nor was there any difference in these scores depending on treatment with inhaled or topical steroids.

Nutrient intakes

A total of 62 (65%) out of the 96 children with food allergies and 52 (55%) of the children in the

Table 1. Nutritional status of children with food allergies compared with controls

	Children with food allergies (n = 96) Mean (SD)	Controls (n = 95) Mean (SD)
Z score weight for age	0.1 (1.6)	0.6* (1.2)
Z score height for age	0.2 (1.5)	0.8* (1.4)
Z score weight for height	-0.2 (1.4)	-0.1 (1.3)

SD, standard deviation.

* $p < 0.05$ compared to controls.

Table 2. Nutritional status of children according to the number of food allergies

	Controls (n = 95) %	Allergy to 1 or 2 foods (n = 55) %	Allergy to more than 3 foods (n = 41) %	All children with food allergies (n = 96) %
Z score weight for age				
< -2	0	1.8	14.5*	9.3**
-2 to +2	82.4	89.1	73.4	80.3
> +2	17.6	9.1	12.1	10.4
Z score height for age				
< -2	2.7	3.6	12.1*	7.2**
-2 to +2	74.3	87.3	75.8	82.2
> +2	23	9.1	12.1	10.6
Z score weight for height				
< -2	8.1	1.9	9.8	5.3
-2 to +2	87.8	88.5	85.4	87.2
> +2	4.1	9.6	4.8	7.5

* $p < 0.05$ compared to allergies to 1 or 2 foods.

** $p < 0.05$ compared to controls.

control group completed usable diet records. There was no difference in the growth of children who had filled their records and those who had not. The mean energy intakes of both populations met with recommended levels but 24% of children with food allergies and 23% of controls received energy intakes below recommended levels. The mean protein intakes of both populations were superior to recommended levels. Children with food allergies had equivalent energy, proteins, fat, carbohydrates, phosphorus and iron intakes to those in the control population (Table 3). Daily calcium intakes were similar

Table 3. Daily nutrient intakes of children with food allergies compared with controls

	Children with food allergies (n = 62)		Controls (n = 52)	
	Mean (SD)	% RDA (SD)	Mean (SD)	% RDA (SD)
Energy (kcal)	1230.6 (351)	119 (38)	1195.6 (284)	117 (21)
Protein (g)	48.8 (17)	418 (14)	47.2 (14)	394 (106)
Fat (g)	45 (16)	—	45.3 (13)	—
Carbohydrates (g)	159.4 (48)	—	148.5 (34)	—
Food calcium (mg)	648.3 (310)	108 (60)	783.6 (600)	129 (90)
Total calcium (mg)	759.8 (291)	128 (52)	783.6 (600)	129 (90)
Iron (mg)	8.3 (3)	114 (47)	7.2 (2)	101 (30)
Magnesium (mg)	166.3 (112)	158 (142)	151.8 (60)	143 (72)
Phosphorus (mg)	726.2 (311)	173 (76)	788.3 (223)	187 (55)
Vitamin C (mg)	61 (39)	93 (37)	57.9 (42)	69 (61)
Vitamin D (μ g)	3.6 (4)	38 (85)	2.7 (3)	29 (38)
Vitamin A (μ g)	336.5 (109)	95 (121)	222.8 (106)*	65 (35)*
Vitamin E (mg)	5.2 (5)	92 (127)	3.3 (1)*	53 (35)*

* $p < 0.05$ compared to controls.

SD, standard deviation; RDA, recommended daily allowance.

in the two groups, whether or not the calcium supplement was included in the assessment, and both groups met the recommended levels. Vitamin A and E intakes were higher in children with food allergies than in controls. Vitamin D intake from food was similar in both groups but both were below the recommended levels.

Of the 28 children allergic to cow's milk, 14 received calcium supplement and 27 received cow's milk substitutes: three received soy-based formula, 16 received extensively hydrolysed formulas and eight received amino acid-based formula. Energy intakes among those children were equivalent to controls. Their protein intakes met with recommended levels but were lower than controls (mean difference -19.8 g, 95% CI $[-27.6; -12.1]$, $p = 0.03$). Their food calcium intakes were also lower than controls (mean difference -287.7 mg, 95% CI $[-433.9; -141.5]$, $p = 0.007$), but their total calcium intake including supplements met with the recommended levels and was equivalent to controls.

Energy intakes of children with food allergies who had had a dietician consultation were not different from those who did not have professional counselling. Equally, energy intakes of children allergic to one or two foods were not different from those of the children allergic to three foods or more.

Discussion

We described nutrient intakes and growth parameters in food allergic children who had received nutrition counselling by a dietician. A small number of studies about this subject exist in the literature. They mostly concern children allergic to cow's milk (7–9). We found that children with various allergies had weight and height within the range of normality but were smaller and lighter for their age than the controls. Children allergic to three or more foods were smaller than children allergic to one or two foods. Growth was not influenced by the existence of asthma, nor by treatment with ICS or topical steroids. The nutrient intakes of children with food allergies met with the nutritional recommendations and were similar to the intakes of the control children. No difference in energy and nutrient intakes was observed between the two populations or according to the number of foods the children were allergic to.

We studied children with allergies to various foods, but our population might not represent the global population of children with food allergies. The children came from a tertiary hospital to which they were referred because of

the severity of their allergies. They had a high prevalence of multiple food allergies, and most of them had received specialized dietetic advice. The diagnosis of food allergy in our population fulfilled the criteria described earlier but was not always ascertained by a positive oral food challenge (2, 15). This could lead to an overestimation of the number of multiple food allergic children. The dietary record method we used to evaluate nutrient intake can provide quantitatively accurate information on food consumed during the recording period but may alter dietary behaviour during the recording period (12). Finally, our aim was a focus on the nutritional status at the time of the study. We assessed the severity of the symptoms during but not prior to the elimination diet. We did not follow-up the growth of the children during elimination diet, and therefore, we could not evaluate their growth pattern.

We found a relationship between the number of foods the children were allergic to and their height. This confirms the results found in a similar study comparing 98 children with various food allergies to control children with no food allergy. Children allergic to two or more foods were smaller than those allergic to only one food (10).

We confirmed previous studies assessing the growth of children allergic to cow's milk showing that they were smaller than controls despite similar energy intakes (6–8). Isaulori et al. studied the growth of 100 children (median age 7 months) allergic to cow's milk following an elimination diet including milk substitute and calcium supplement. Their W/A and H/A Z scores were lower than controls with energy and protein intakes following recommendations. There was no catch-up growth at the age of 24 months (16).

In our study, inadequate nutrient intake cannot explain the difference in the growth pattern of children with food allergies. With appropriate nutrition counselling, children with food allergies managed to have nutrient intakes matching the recommended levels and similar to non-allergic children having normal growth. One possible explanation could be the loss of nutrients caused by continuous allergic inflammation and abnormal intestinal permeability despite the eviction diet (17). We did not find any difference in the growth of children with and without a history of gastro-intestinal symptoms in our population but no children had persistent digestive symptoms under elimination diet. Persistent intestinal inflammation could be caused by continuous antigen challenge from non-compliance with the

diet, undiagnosed allergy or antigen remnants in the substitute formula. Amino acid-based formulas have been reported to effectively alleviate residual symptoms that do not respond to hydrolysates in cow's milk allergy (18, 19). Another possible explanation could be the higher caloric and protein needs of children with moderate to severe atopic dermatitis based on the degree of skin involvement. Isolauri et al. found that the albumin of children with cow's milk allergy and atopic dermatitis was lower than healthy controls having the same protein intakes (16). In our study, 63% of the children with food allergies had atopic dermatitis, 38% had persistent symptoms. However, we did not find any difference in the growth of children with and without atopic dermatitis in our population. We also evaluated the growth of food allergic children depending on asthmatic symptoms. ICS could affect the growth pattern of asthmatic children although the growth deceleration may be compensated after the first year of treatment (20, 21). We did not find any difference between the growth of the 69% of children with asthma in our study (whether or not they received inhaled steroids) and those without asthma. We did not evaluate the duration of steroid treatment.

In our study, we evaluated calcium and other nutrient intakes. Children allergic to cow's milk had food calcium intakes lower than controls. Their total calcium intakes including calcium supplements were normal and similar to controls. This confirms the result of Tianen study, where children allergic to cow's milk also received milk substitutes and calcium supplement (7). Children allergic to cow's milk receiving no or little calcium supplement have calcium intakes lower than controls (22, 23). This result enhances the importance of milk substitution by extensively hydrolysed formulas or amino acid-based formula and appropriate calcium supplement in cow milk-allergic children. The increased vitamin E and A intakes in children with food allergies can be explained by the addition of vegetable oils as recommended by our dieticians.

Conclusion

Our study confirms the importance of a global approach for children with food allergies to ensure diagnosis, treatment, adequate diet and growth survey. Concerning the diet strategy, this should include the following: (1) a careful initial education about label reading, hidden allergens and advice on food substitutes; (2) regular assessment of the degree of compliance with the eviction diet; (3) initial and regular

assessment of nutrient intakes to detect nutritional deficiencies and give adequate substitutes and supplements; and (4) regular growth evaluation.

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