

Prevalence and main characteristics of schoolchildren diagnosed with food allergies in France

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Summary

Background A cross-sectional, descriptive, questionnaire-based survey was conducted in Toulouse schools to determine the prevalence of food allergies among schoolchildren.

Objectives The first goal of the survey was to estimate the prevalence of food allergies. The second goal was to determine the main characteristics of the allergies.

Methods The questionnaires (3500) were distributed in 150 classes in eight schools. The return rate was 77.6% (2716).

Results Of the 192 (7.0%) questionnaires with a 'Yes' response (report of a food allergy), 182 were retained as reporting true food allergies (6.7%). The cumulative and point prevalences were 6.7% [95% confidence interval (CI) 5.8–7.6] and 4.7% [95% CI 3.9–5.5], respectively. The point prevalences were 4.0% for the children aged 2–5 years, 6.8% for the children aged 6–10 years, and 3.4% for the children aged 11–14 years. The main foods reported as causing adverse reactions were cow milk ($n = 29$, 11.9%), eggs ($n = 23$, 9.4%), kiwis ($n = 22$, 9.0%), peanuts ($n = 20$, 8.2%), fish ($n = 19$, 7.8%), tree nuts ($n = 19$, 7.8%), and shrimp ($n = 13$, 5.3%). The average age at which the allergies were detected was 3.4 ± 2.8 years (with a range of 0.1–12 years). The clinical signs of the food allergies were cutaneous ($n = 153$, 62.7%), digestive ($n = 74$, 30.3%), respiratory ($n = 17$, 6.9%), and anaphylactic shock ($n = 12$, 4.9%).

Conclusion While well aware of the biases inherent in this type of study, we estimated the cumulative and point prevalences of food allergies in a population of schoolage children in Toulouse at 6.7% and 4.7%, respectively. Cow milk, eggs, and peanuts were the main foods reported as causing allergies. Exotic fruits, shellfish, and tree nuts appeared to be relatively new allergens.

Keywords children, food allergy, prevalence, questionnaire survey

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Introduction

Little information on the prevalence of food allergies is available. Recent studies have suggested that the prevalence of certain food allergies in children is on the rise, although it is difficult to ascertain the true rate of increase because of the differences in methodologies [1, 2]. Studies on the general population have estimated the overall prevalence of food allergies at between 1.4% and 4% [3–5]. A study in the United States on children under 4 years of age estimated the prevalence at 6% [6]. There have been very few epidemiological studies of children in France. We report here the results of a descriptive, questionnaire-based, epidemiological survey to determine the incidence of food allergies in schoolchildren 2–5, 6–10, and 11–14 years of age. We also report the distribution and characteristics of the food allergies in the children.

Material and methods

Questionnaire

We used a standard, anonymous questionnaire to gather demographic data and the answer to the following question: 'Has your child ever had an allergic reaction to food?' If the response was 'Yes', the parents were asked to respond to additional questions to gather clinical and treatment data and the results of allergy tests. There was no pre-determined list and the parents were asked to write down each food involved in an adverse reaction. In the case of a positive response to the first question, the parents were asked to specify the food that caused the adverse reaction. For each food reported as causing an adverse reaction, the age at the first reaction, clinical signs, triggers (contact, inhalation, ingestion), location (home, school, other), type of treatments for allergic reactions, allergy tests performed, and associated atopic symptoms were recorded. The parents were also asked whether the allergy had disappeared or had persisted, whether the allergic reaction had occurred once or more, and whether there was a personal or family history of allergy. The

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questionnaire was pre-tested with 20 allergic children who had come to the allergology department of the Toulouse children's hospital.

We wanted to recruit 2000 children, which would enable us to estimate the prevalence of food allergies to within $\pm 0.4\%$ with a 95% confidence interval (95% CI), assuming the prevalence was 8% or less. Given an anticipated response rate of 70%, approximately 3000 children would have to be contacted to attain the desired sample size. Thirteen schools (pre-school, primary, and elementary levels) in Toulouse were contacted. Five schools refused to participate. The questionnaire was distributed in September 2002 to eight schools with a total of 3500 students.

Patient consent

The parents received detailed information on the survey and gave their informed consent. The survey was approved by the regional academic evaluation service.

Statistical analysis

The quantitative results are presented as means $\pm$ SD and were compared using ANOVA and an *a posteriori* Scheffer's test. The χ^2 test was used for comparisons and the Fisher test was used for small samples. The significance level was set at $P < 0.05$ for all the tests [7]. The statistical analyses were performed using Stata software (Stata Corporation 1999, Stata Statistical Software: Release 6.0, College Station, TX, USA).

Results

Overall results

Questionnaires (3500) were distributed in 150 classes in eight schools. The return rate was 77.6% (2716). The main characteristics are presented in Table 1. The overall average age was 8.9 ± 2.6 years (2.5–14 years of age). There were 1340 boys and 1376 girls (sex ratio M/F 0.97). There were 402 (13.4%) children aged 2–5 years, 1011 (49.2%) aged 6–10 years, and 1303 (36.5%) aged 11–14 years.

Of the questionnaires returned, 2524 (92.9%) reported no food allergies. Of the 192 questionnaires reporting a food allergy, ten were excluded because the foods indicated were absurd (food colouring (4), French fries for children who were not reported as being allergic to potatoes and peanuts (2), and Gruyere cheese for children with no allergy to cow

milk (4)). There were 244 different foods cited. The average age of the allergic children was 8.9 ± 2.7 years.

Overall, the cumulative prevalence was 6.7% (95% CI 5.8–7.6) and the point prevalence was 4.7% (95% CI 3.9–5.5). Table 1 presents the cumulative and point prevalences as a function of age. The cumulative and point prevalences were significantly higher in the 6–10-year-old group. Surprisingly, the cumulative prevalence was low in the 11–14-year-old group.

Prevalence of types of allergies

The foods ($n = 244$) cited were the following: fish and shellfish ($n = 38$, 15.5%), cow milk ($n = 29$, 11.9%), exotic fruit (29, 11.9%), eggs ($n = 23$, 9.4%), peanuts ($n = 20$, 8.2%), and tree nuts ($n = 19$, 7.8%). Other foods of plant origin were cited 69 times (28.2%) and other foods of animal origin were cited 10 times (4.1%). Greater detail is provided in Table 2.

One hundred and forty-five (79.7%) of the children were reported as having one food allergy while 23 children (12.6%) had two food allergies, five (2.7%) had three food allergies, seven (3.8%) had four food allergies, one (0.5%) had six food allergies, and one (0.5%) had seven food allergies.

The average age when the food allergies were detected was 3.5 ± 2.8 years (with a range of 0.1–12). The only allergy for which the age of appearance differed significantly from the overall average was the allergy to cow milk (0.6 ± 0.9 years, with a range of 0.1–5 years, $P = 0.01$).

Table 2. Percentages of foods causing food allergies in 182 allergic children (244 foods reported)

Food	N	%
Cow milk	29	11.9
Eggs	23	9.4
Kiwis	22	9.0
Peanuts	20	8.2
Fish	19	7.8
Tree nuts	19	7.8
Shrimp	13	5.3

Tree nuts: hazelnuts (10), walnuts (6), almonds (2), cashews (1), unspecified (1).

Others: strawberries (8), pineapples (7), tomatoes (10), beef (9), oranges (5), wheat (5), mustard (5).

In three cases (1.2%): crab, mushrooms, chocolate, lemons, apples.

In two cases (0.8%): carrots, corn, mussels, grapes.

In one case (0.4%): garlic, avocados, bananas, beets, celery, cherries, cabbage, cucumbers, turkey, snails, beans, raspberries, oysters, melon, honey, peaches, parsley, potatoes, plums, rice, buckwheat, soy, vanilla.

Table 1. Food allergies according to age group (2716 schoolchildren)

Age (years)	Number of responses	Cumulative		Prevalence		Point prevalence	
		N	%	95% CI	N*	%	95% CI
2–5	402	24	6.0	3.7–8.3	16	4.0	2.1–5.9
6–10	1011	100	9.9	8.1–11.7	69	6.8	5.3–8.4
11–14	1303	58	4.5	3.3–5.6	44	3.4	44.2–4.4
Total	2716	182	6.7	5.8–7.6	129	4.7	3.9–5.5

CI, confidence interval.

*We do not have an answer to the question 'Did your child outgrow the allergy?' for three children.

Table 3. Recovery from food allergies of the 182 schoolchildren with food allergies (244 foods)

Food	N	Recovery, N (%)	Average age at recovery (years $\pm$ SD)	Cumulative prevalence (%), (95% CI)	Point prevalence (%), (95% CI)
Milk	29	17 (58.6)***	3.6 $\pm$ 1.9	1.1 (0.7–1.5)	0.4 (0.2–0.7)
Eggs	23	9 (39.1)	4.7 $\pm$ 3.0	0.8 (0.5–1.2)	0.5 (0.2–0.8)
Peanuts	20	3 (15.0)	6.3 $\pm$ 2.5	0.7 (0.4–1.1)	0.6 (0.3–0.9)
Shellfish†	38	3 (7.9)	6.7 $\pm$ 3.5	1.4 (1.0–1.8)	1.3 (0.8–1.7)
Exotic fruits	29	4 (13.8)	5.7 $\pm$ 3.0	1.1 (0.7–1.5)	0.9 (0.6–1.3)
Tree nuts	19	0***	–	0.7 (0.4–1.1)	0.7 (0.4–1.1)
Other plant foods‡	69	17 (24.6)	6.0 $\pm$ 2.0	2.5 (1.9–3.1)	1.8 (1.3–2.3)
Other animal foods	10	3 (30.0)	6.0 $\pm$ 2.0	0.4 (0.1–0.6)	0.3 (0.1–0.4)
Not specified	7	3			
Total	244	60 (24.6)	5.2 $\pm$ 2.48		

CI, confidence interval.

*** $P = 0.001$.

†One not specified.

‡Three not specified.

Sixty-two (25.4%) of the children outgrew their food allergies (Table 3). The average age when the allergy disappeared was 5.1 years. There was a significantly higher recovery rate for the allergy to cow milk than the other food allergies ($n = 16$, 55.2%, $P < 0.001$, with an average age of 3.6 ± 2.06 years). The children never outgrew allergies to fruit nuts. For analytical purposes, the food types were distributed into the following groups: fish and shellfish, kiwi and other exotic fruits, foods of animal origin, and foods of plant origin. Table 3 presents the cumulative and point prevalence for each of these groups. Table 4 presents the point prevalences as a function of age and the different types of allergies.

Main clinical characteristics of food allergies

The food allergies were triggered by ingesting a food in 221 of the 249 (88.7%) reactions reported. Other triggers were contact with the food (5), inhalation (2), ingestion and contact (8), ingestion and inhalation (5), and simultaneous ingestion, contact, and inhalation (1).

The clinical signs of allergy were cutaneous for 153 (62.7%) of the 244 signs cited, with a significantly higher frequency for the fish and shellfish group (76.3%, 29/38, $P < 0.05$) (Table 5). Digestive signs were reported 74 (30.3%) times, with a significantly lower frequency for the fish and shellfish group (15.7%, 6/38, $P = 0.03$). The other signs of food allergy reported were respiratory ($n = 17$, 6.9%) and anaphylactic shock ($n = 12$, 4.9%), with no significant differences between food groups for these two clinical signs. Allergies were diagnosed by allergy tests without consumption of a food in 12 children (4.9%).

First allergic reactions occurred at home in 199 cases (81.5%), at school in 21 cases (8.6%), at a restaurant in 10 cases (4.0%), and in various other locations in 14 cases (5.7%).

No treatment was given in 95 of the 244 reactions reported (38.9%). An antihistamine was given in 71 cases (29.0%), oral corticosteroid in 15 cases (6.1%), and injectable corticosteroid in a single case (0.4%). Antihistamines combined with

Table 4. Point prevalence of different types of allergy as a function of age of the 182 schoolchildren with food allergies (244 foods)

Food	2–5 years (%)	6–10 years (%)	11–14 years (%)
Milk	1.0	0.6	0.2
Eggs	0.7	0.8	0.2
Peanuts	0.7	1.0	0.2
Shellfish*	0.2	1.8	1.2
Exotic fruits	0.0	1.6	0.7
Tree nuts	1.7	1.0	0.2
Other plant foods†	1.5	2.3	1.5
Other animal foods	0.0	0.5	0.2
Not specified	0.0	0.0	0.2

*One not specified.

†Three not specified.

oral corticosteroids were used in 41 cases (16.8%). Hospitalizations occurred in 18 cases (7.3%).

Of the 175 responses to this question, 102 (58.3%) children had one allergic reaction, 24 (11.7%) had two allergic reactions, 19 (8.3%) had three allergic reactions, and 30 (17.1%) had more than three allergic reactions. In the case of multiple reactions (146/175), the subsequent allergic reactions had the same intensity as the first for 93 (63.7%) children, were stronger for 19 (13.0%), and were weaker for 17 (11.6%). The reactions were always different for 17 (11.6%) children.

While 211 (211/244, 86.4%) cases of food allergy were diagnosed by a doctor, allergic tests were not performed in 79 (32.3%) cases (Table 5). Skin tests detected 88 cases (36.0%), specific IgE assays (the technique was not specified) detected 68 cases (27.8%), while a combination of skin tests and specific IgE assays detected 43 cases (17.6%). Oral food challenges were performed in 53 cases (21.7%). Oral food challenges were performed more often in the case of allergies to cow milk (11, 37.9%, $P = 0.05$) and eggs (12, 52.2%, $P = 0.001$), compared with the other food allergies.

Associated clinical signs were reported in 168 cases (168/233, 72.1%). These included asthma in 95 cases (40.7%),

Table 5. Clinical signs of the 182 schoolchildren with food allergies (244 foods)

Food	N	Cutaneous, N (%)	Gastrointestinal, N (%)	Respiratory, N (%)	Anaphylactic shock, N (%)
Milk	29	7 (24.1)	12 (41.3)	2 (6.9)	4 (13.7)
Eggs	23	14 (60.8)	8 (34.8)	2 (8.7)	1 (4.3)
Peanuts	20	14 (70)	4 (20)	4 (20)	1 (5)
Shellfish	38	29 (76.3)*	6 (15.7)**	2 (5.2)	2 (5.2)
Exotic fruit	29	13 (44.8)	13 (44.8)	1 (3.4)	0
Tree nuts	19	11 (57.8)	7 (36.8)	2 (10.5)	1 (5.2)
Other plant foods	69	42 (60.8)	19 (27.5)	4 (5.8)	2 (2.9)
Other animal foods	10	6 (60)	4 (40)	0	1 (10)
Not specified	7				
Total	244	153 (62.7)	74 (30.3)	17 (6.9)	12 (4.9)

* $P < 0.05$; ** $P = 0.03$.

allergic rhinitis in 53 cases (24.0%), and atopic eczema in 109 cases (46.8%). More than one related clinical sign were occasionally reported for the same child.

A family history of atopic disease was reported in 178 cases (178/219, 81.3%) and a family history of food allergy in 28 cases (12.8%).

Discussion

We conducted a cross-sectional study of the prevalence of food allergies in children in the general population.

Epidemiological surveys of food allergies are relatively rare compared with asthma, allergic rhinitis, and atopic eczema surveys [8, 9]. Three studies reported the prevalence of food allergies in the general population, all ages included. The investigation by Young et al. [4] in the United Kingdom was based on a questionnaire given to 20 000 individuals, followed by a double-blind challenge test. Based on their statistical analysis, they estimated the prevalence of food allergies in the general population at 1.4–1.8%. The investigation by Niestijl Janssen et al. [5] in Holland used a similar methodology and estimated the prevalence of food allergies at 2–3%, a slightly higher rate. In France, Kanny et al. [3] sent questionnaires to 44 000 people (20 000 households). They had a response rate of 75% (33 110/44 000) and estimated the prevalence of food allergies at between 2.1% and 3.8%.

Food allergies are more frequent in children than in the general population. Three times as many children as adults have a food allergy [10]. In the United States, the prevalence of food allergies in children was estimated at 6% in 520 consecutive babies investigated over the first 3 years of life using double-blind, placebo-controlled food challenges [6].

While most studies on food allergies have looked at a single food, our survey examined the whole range of food allergies in children in the general population. We were able to estimate the point prevalence of food allergies in children aged 2–14 years at 4.7% [95% CI 3.9–5.5]. Our questionnaire had some inherent bias because of the subjectivity of the answers. The initial question (Has your child ever had an allergic reaction to food?) may have underestimated the true prevalence of food allergies, especially transitory food allergies.

While we had a response rate of 77.6%, which is satisfactory for this type of survey, the prevalence estimates may have been biased insofar as we cannot assert that the non-responders were identical to the responders. The non-responders were thus a source of bias that might have underestimated the prevalence of food allergies. Despite this, we are in a position to assert that the point prevalence was at least 3.7% (95% CI 3.1–4.3), or 129 of 3500 children, based on the answers to the initial question. However, the results must be interpreted with caution because of the possible biases. The quality of the responses was also a source of bias. The questions covered the age span of 2–14 years. This points to a recall bias. The goal of the questions was to record instances of all allergies, including those that had been outgrown, which allowed us to calculate the cumulative prevalence. However, the results were debatable. We expected that the cumulative prevalence would increase regularly with age. However, the children aged 11–14 displayed a clearly lower prevalence than the children aged 6–10 and a prevalence identical to the children 5 years and under. This result points to a recall bias. However, we cannot preclude a possible generational effect leading to a true increase in food allergies in the younger children. The initial size of our sample made it impossible to conduct a very precise survey of the different types of allergy as a function of age. The results presented in Table 4 thus have an indicative value only. They are, however, consistent with the classic tendency of allergies such as milk and egg to drop off with age [1, 11]. On the other hand, they point to an increase in peanut allergy among young children, which most do not outgrow [12].

The selection of the study population, which was entirely urban, may also have introduced biases.

In our survey, the prevalence of peanut allergy, as perceived by the parents, was 0.7% (20/2716). This rate was slightly higher than that obtained by Lack et al. [13], who reported that in a cohort of 13 971 children, 49 (0.35%) were allergic to peanut based on a questionnaire and 23 (0.16%) were allergic based on a DBPCFC.

According to the literature (regardless of the geographical region surveyed), cow milk, eggs, and peanuts are the three foods mainly responsible for food allergies in children [10, 13–16]. The survey reported here produced comparable results. It also revealed a dramatic rise in allergies to shellfish, exotic fruits like kiwis, and tree nuts, compared with previous reports [10]. Tree nut allergies are on the rise in France [14],

which is in agreement with recent data from the United States and Australia [2, 15, 16].

Food allergies begin at an early age. The age of appearance in our study population was under 6 years. While the result for the age of appearance of food allergies must be treated with caution because of a possible recall bias, it is in agreement with other reports [6, 17–20].

Anaphylactic shock, the most serious sign of food allergy, accounted for 4.9% of the signs reported in our survey, which was very similar to the percentage reported in a previous study [9]. Anaphylactic shock as a result of food allergies occurs more frequently in adults than in children [21–24]. In addition, digestive signs are rarely reported for food allergies in children, but account for 30% of the signs reported in adults.

One-half of the children outgrew their milk allergy at an average age of 3.6 years. This rate, which is lower than those previously reported [11, 25], may be because of the recall bias mentioned above. Only 15% of the children outgrew their peanut allergy, which is also in agreement with previous reports [12, 26, 27]. None of the tree nut allergies disappeared and no studies on their natural evolution have been published.

Allergic tests had not been performed for 32.3% of the children surveyed. The double-blind oral food challenge test is universally recognized as the gold standard for confirming the diagnosis of food allergy (with the exception of anaphylactic shock and threshold-specific IgE values). Toxic or infectious reactions can occasionally cause allergy-like symptoms and this cannot be excluded by a questionnaire. In our survey, double-blind food challenges had been performed for 21.7% of the children. The low number of subjects with allergy test results was also confirmed by a previous Web-based investigation [28]. Eigenmann et al. analysed the responses to a Web-based questionnaire by 264 patients who had suffered from anaphylactic shock after eating a food and reported that 29.5% of the subjects had never undergone allergy testing.

In summary, the cumulative prevalence of food allergies in schoolchildren in Toulouse was 6.7%, and the point prevalence was 4.7%. Cow milk, egg, and peanut allergies were the main allergies reported. Shellfish, exotic fruit, and tree nut allergies appear to be on the upsurge and a possible cause for concern. In addition, allergy testing was clearly insufficient. The survey should be continued to confirm the food allergies using double-blind oral challenge tests, which is a recommended practice for allergy testing in children [29–31].

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