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ARTICLE ORIGINAL

Prevalence of challenge-confirmed food allergy among children younger than 5 years in Beni Messous, Algiers: a population-based cross-sectional study

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KEYWORDS

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Oral food challenge;

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Prevalence

Abstract

Background : Reliable population-based data on food allergy (FA) in preschool-aged children are scarce in North Africa, particularly estimates confirmed by oral food challenge (OFC). We estimated the prevalence and clinical profile of OFC-confirmed FA among children younger than 5 years in Algiers, Algeria.

Methods : We conducted a population-based cross-sectional study in Beni Messous using stratified multistage cluster sampling. Household interviews were conducted from January to March 2020, and allergy assessment continued through August 2020. Children with suspected current FA underwent standardized evaluation including skin prick testing, serum-specific IgE measurement, and open OFC irrespective of sensitization results.

Results : Among 690 children, lifetime and current parent-reported FA prevalences were 5.9% (95% CI 4.4-8.0) and 4.9% (95% CI 3.5-6.8), respectively. Prevalence decreased to 3.2% after allergy-focused assessment and 2.3% when a compatible history was supported by sensitization. Twenty-one children underwent 24 OFCs, 17 of which were positive, confirming FA in 14 children. OFC-confirmed prevalence was 2.0% (95% CI 1.2-3.4). Cow's milk was the leading allergen (population prevalence, 1.0%), followed by egg (0.4%), fish (0.3%), and non-peanut legumes (0.3%). IgE-mediated FA predominated (1.5%); non-IgE-mediated

and mixed FA accounted for 0.4% and 0.1%, respectively. Anaphylaxis prevalence was 0.7%.

Conclusions : Parental report substantially overestimated clinically relevant FA. This first population-based, OFC-confirmed estimate in Algerian preschool-aged children underscores the diagnostic value of OFC and highlights a culprit-food profile influenced by regional dietary exposure.

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Introduction

Food allergy (FA) is an important public health concern, particularly in early childhood, when many common food allergies first manifest and food-induced anaphylaxis is frequent (1-4). Beyond its clinical consequences, FA may impair growth and nutritional status, substantially reduce the quality of life of affected children and their families, and impose a considerable psychosocial and economic burden (5-7).

Accurate diagnosis of FA remains challenging despite advances in allergy diagnostics. Parent-reported FA consistently overestimates the prevalence of clinically relevant disease, whereas sensitization demonstrated by skin prick tests (SPTs) or serum-specific IgE (sIgE) does not necessarily indicate clinical allergy (1, 8-10). In addition, the prevalence and spectrum of FA vary according to age, dietary practices, geographical setting, ethnicity, and diagnostic method (4, 9-11). Population-based estimates based on standardized diagnostic criteria are therefore essential to quantify the burden of FA and guide clinical and public health strategies.

Although the epidemiology of FA has been extensively investigated in Europe, North America, and several Asian countries, population-based data from North Africa remain scarce. Most available studies rely on self-reported allergy or sensitization, both of which may overestimate clinically relevant FA (8-10). Regional differences in infant feeding, dietary habits, environmental exposures, and access to allergy services also limit the generalizability of findings from other populations. Studies incorporating oral food challenge (OFC), the reference standard for FA diagnosis, are therefore needed in this region. To our knowledge, no previous population-based study using OFC has estimated FA prevalence among preschool children in Algeria.

The primary objective of this study was to estimate the prevalence of OFC-confirmed FA among children younger than 5 years residing in the municipality of Beni Messous, Algiers, Algeria, using a standardized stepwise diagnostic algorithm. Secondary objectives were to

characterize culprit foods and clinical phenotypes and to estimate the prevalence of food-induced anaphylaxis.

Materials and methods

Study design and setting

A population-based cross-sectional study was conducted among children aged 0-59 months residing in the municipality of Beni Messous, Algiers, Algeria. Household interviews were conducted from 12 January to 28 March 2020 using a standardized questionnaire. Children with suspected FA subsequently underwent a comprehensive allergological assessment, which continued through August 2020. The overall study lasted seven months.

The sample-size calculation assumed an expected FA prevalence of 5% (1), a 95% confidence level, a design effect of 2, and an absolute precision of 2.5%. After finite population correction for an estimated source population of 5,715 children younger than 5 years, approximately 530 participants were required. Allowing 10% for non-response and rounding up gave a minimum target of 600 children. To ensure that this target was achieved across the 30 clusters, the operational sampling plan sought to enroll 23 eligible children per selected district, corresponding to a planned sample of up to 690 children.

The National Office of Statistics and the National Institute of Public Health assisted in developing the stratified multistage cluster sampling design. Of the municipality's 44 districts, 30 were selected using probability-proportional-to-size sampling within urban and rural strata; 24 were urban and six rural. Within each selected district, households were selected by systematic random sampling, with a sampling interval ranging from 4 to 15 according to district size. When a household included more than one eligible child, one was randomly selected using the Kish method. Households with no eligible resident child, those that remained unavailable, and those that declined participation were replaced by a neighboring household according to the predefined field procedure.

Questionnaire

The questionnaire was adapted from the European Academy of Allergy and Clinical Immunology (EAACI) Standardised Diet History Tool to Support the Diagnosis of Food Allergy in Children (12). It was written in French and administered by trained physicians, who formulated the questions in Algerian Arabic when required. It was pilot-tested in 10 households from a non-selected district before the survey and refined accordingly.

The questionnaire collected demographic characteristics; history of FA; detailed information on suspected reactions, including the culprit food, age at onset, symptoms, timing, reproducibility, and outcome; and potential associated factors, including infant feeding practices, antibiotic exposure during the first year of life, personal and family histories of atopy, socioeconomic characteristics, and perinatal factors. Because the International Study of Asthma and Allergies in Childhood (ISAAC) questionnaire has not been validated in children younger than 5 years, personal atopy was defined as a physician-diagnosed allergic disease or use of disease-specific treatment.

Children with a history suggestive of current FA were referred for allergological evaluation, including clinical examination, SPT, sIgE measurement, and OFC. The clinical examination, SPT, and blood sampling were performed on the same day.

Diagnostic procedures

Skin prick testing

SPTs were performed using the prick-to-prick technique with fresh foods, raw or cooked as appropriate. Histamine (10 mg/mL) and saline served as positive and negative controls, respectively. Tests were read after 20 minutes, and a wheal diameter at least 3 mm greater than the negative control was considered positive (13). Children with suspected pollen-food allergy syndrome (PFAS) were also tested against relevant aeroallergens.

Serum-specific IgE

sIgE levels were measured using the IMMULITE® chemiluminescent immunoassay for all available suspected allergens. Values at least 0.35 kU/L were considered positive according to the manufacturer's recommendations (14). Targeted component-resolved diagnostics (ImmunoCAP®) were performed when PFAS was suspected.

Oral food challenge

Open OFCs were planned for all children with suspected FA, irrespective of SPT or sIgE results, after a 2-6-week elimination period and discontinuation of medications that could interfere with challenge interpretation (15-16). OFCs were

generally performed approximately four weeks after the initial allergological assessment, in a pediatric day-care unit with resuscitation facilities. Standardized protocols followed American Academy of Allergy, Asthma & Immunology (AAAAI) recommendations, using low- or high-risk schedules according to the clinical history and sensitization profile (17-18). Children with suspected food protein-induced enterocolitis syndrome (FPIES) underwent a dedicated challenge protocol according to international recommendations (19).

An OFC was considered positive when objective clinical signs or persistent, clinically relevant subjective symptoms occurred and required challenge interruption. Children without symptoms during the supervised challenge continued half of the tolerated dose at home for seven days. Recurrence of the index delayed symptoms during this period was considered a positive result; for atopic dermatitis, an increase in the SCORing Atopic Dermatitis (SCORAD) was required. Children remaining asymptomatic resumed an unrestricted diet and were reassessed three months later.

Definitions

FA was classified according to successive diagnostic stages as parent-reported FA, current parent-reported FA, clinically suspected FA, FA supported by evidence of sensitization (positive SPT and/or sIgE), and OFC-confirmed FA.

- IgE-mediated FA was defined as reproducible symptoms occurring within 2 hours of food ingestion in a sensitized child and confirmed by OFC.
- Non-IgE-mediated FA was defined as delayed, reproducible symptoms confirmed by OFC despite negative IgE-mediated investigations.
- Mixed FA was defined as FA associated with atopic dermatitis and delayed eczematous worsening after OFC, documented by an increase in the SCORAD.
- Food-induced anaphylaxis was defined according to the World Allergy Organization diagnostic criteria (20).

The study flow diagram is shown in Figure 1.

Statistical analysis

Data were entered in EpiData version 3.1 and checked and analyzed using Epi Info™ version 6.04. Categorical variables were summarized as frequencies and percentages, and continuous variables as mean ± standard deviation. Prevalence estimates are reported with 95% confidence intervals. Group comparisons were performed using the chi-square test or Fisher's exact test for categorical variables and Student's t-test or the

Kruskal-Wallis test for continuous variables, as appropriate. Analyses of associated factors were considered exploratory. All tests were two-sided, and $P < 0.05$ was considered statistically significant.

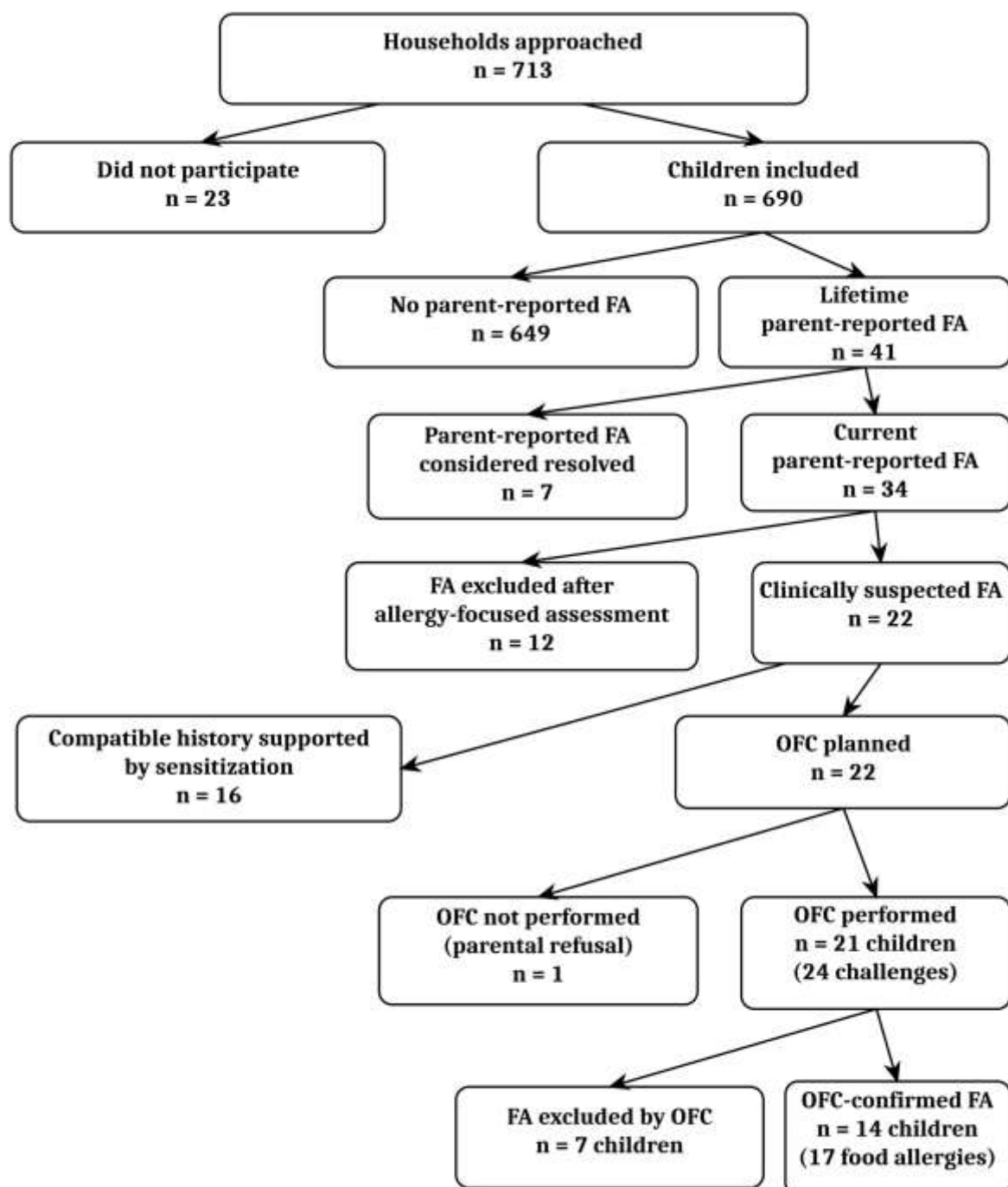
Results

Study population

Through the initial sampling and household-replacement process, 713 households were

approached and 690 contributed one eligible child, yielding a participation rate of 96.8% (Figure 1). The final study population therefore comprised 690 children younger than 5 years living in the municipality of Beni Messous. Their baseline demographic and socioeconomic characteristics are summarized in Table 1.

Figure 1. Study flow diagram



Parent-reported food allergy

Parents of 41 children reported at least one previous adverse reaction attributed to food, corresponding to a lifetime parent-reported FA prevalence of 5.9% (95% CI 4.4-8.0). In seven children, the suspected allergy was considered by the parents to have resolved. The prevalence of current parent-reported FA was therefore 4.9% (34/690; 95% CI 3.5-6.8). Cow's milk was the most frequently reported culprit food, followed by egg and fish (Table 2).

Clinically suspected food allergy

Following a standardized allergy-focused interview, FA was excluded in 12 of the 34 children with current parent-reported FA, mainly because the suspected food had subsequently been consumed repeatedly without symptom recurrence. Strawberry and tomato were the foods most frequently excluded after clinical assessment. FA remained clinically suspected in 22 children, corresponding to a prevalence of 3.2% (95% CI 2.1-4.8).

Food allergy supported by evidence of sensitization

Twenty-five suspected culprit foods were identified among the 22 children undergoing allergological evaluation. SPTs were performed for all 25 foods and were positive for 19 (76.0%), involving 16 children. Serum sIgE could not be measured for goat's milk because the appropriate reagent was unavailable or for potato because the parents declined testing. Among the remaining 23 suspected culprit foods, sIgE results were positive for 17 (73.9%).

Overall, a compatible clinical history and evidence of sensitization, defined as a positive SPT and/or sIgE result, were present in 16 children for 19 foods. The prevalence of clinically suspected FA supported by evidence of sensitization was therefore 2.3% (95% CI 1.4-3.7).

OFC-confirmed food allergy

Open OFCs were performed in 21 children for 24 suspected food allergies. One planned challenge to potato was not performed because the parents declined. At challenge, the mean age was 29.9 months (range, 5.5-58 months). Two children with a clinical history suggestive of FPIES underwent FPIES-adapted OFCs despite negative SPT and sIgE results.

Seventeen of the 24 OFCs were positive (70.8%), confirming 17 food allergies in 14 children. Thirteen of the 17 positive reactions (76.5%) were immediate and occurred within 30 minutes of food ingestion. Cutaneous manifestations, predominantly urticaria, were the most frequent. Anaphylaxis occurred during three positive OFCs (17.6%). All reactions resolved promptly with

appropriate treatment, and none required intensive care. The clinical characteristics of the children with OFC-confirmed FA are summarized in Table 3.

Seven OFCs were negative, excluding FA in seven children, including four evaluated for suspected cow's milk allergy. The prevalence of OFC-confirmed FA was therefore 2.0% (14/690; 95% CI 1.2-3.4).

Among the 34 children with current parent-reported FA, the diagnosis was excluded after specialist assessment in 12 and remained clinically suspected in 22. Of these, 21 underwent OFC. FA was confirmed in 14 and excluded in seven. One child did not undergo the planned OFC because the parents declined (Figure 1).

Distribution of OFC-confirmed culprit foods

Cow's milk was the leading culprit food, with seven confirmed allergies and a population prevalence of 1.0% (95% CI 0.5-2.1), followed by egg, with three confirmed allergies and a prevalence of 0.4% (95% CI 0.1-1.3). Fish and non-peanut legumes each accounted for two confirmed allergies, corresponding to a prevalence of 0.3% (95% CI 0.1-1.1) for each food group. The fish species involved were sardine and whiting, and the implicated legumes were lentil and pea. Tomato, peanut, and goat's milk each accounted for one confirmed allergy, corresponding to a prevalence of 0.1% (95% CI 0.0-0.8) for each food (Figure 2).

Clinical phenotypes of OFC-confirmed food allergy

Among the 14 children with OFC-confirmed FA, 10 had IgE-mediated FA, corresponding to a population prevalence of 1.5% (95% CI 0.8-2.6). PFAS was diagnosed in two of these children, who developed mild oral symptoms after tomato or peanut ingestion. Both were sensitized to grass pollen and the profilin Phl p 12.

Three children had non-IgE-mediated FA, corresponding to a population prevalence of 0.4% (95% CI 0.1-1.3). These included two infants with acute FPIES and one child with food protein-induced enteropathy. Mixed FA was identified in one child, in whom an egg-induced exacerbation of atopic dermatitis was confirmed by OFC and documented by an increase in the SCORAD score.

Five children with OFC-confirmed FA had experienced at least one episode of food-induced anaphylaxis, including three who developed anaphylaxis during OFC. This corresponded to an estimated population prevalence of 0.7% (95% CI 0.3-1.7). Cow's milk was the principal trigger in infants, whereas cow's milk, fish, and lentil were implicated in older children.

Multiple FA was confirmed in three children, corresponding to a population prevalence of 0.4% (95% CI 0.1-1.3). One child was allergic to lentil and

Table 1. Baseline demographic and socioeconomic characteristics (N = 690)

Characteristic	n (%)	Characteristic	n (%)
Age group (months)		Family history of atopic disease	136 (19.7)
<24	294 (42.6)	Asthma	56 (8.1)
24–59	396 (57.4)	Allergic rhinitis	77 (11.2)
Sex		Atopic dermatitis	7 (1.0)
Male	343 (49.7)	Food allergy	28 (4.1)
Female	347 (50.3)	Living environment	
Preterm birth	39 (5.6)	Urban	552 (80.0)
Cesarean delivery	139 (20.1)	Rural	138 (20.0)
Breastfeeding duration		Parental education	
Never breastfed	219 (31.7)	No formal education	6 (0.9)
<2 months	19 (2.8)	Primary school	160 (23.2)
2–4 months	67 (9.7)	Secondary school	234 (33.9)
4–6 months	45 (6.5)	High school/university	290 (42.0)
>6 months	340 (49.3)	Parental occupation (ISCO-08)*	
Solid foods introduced	645 (93.5)	No occupation	25 (3.6)
Age at solid food introduction†		Managers	20 (2.9)
<4 months	149 (23.1)	Professionals	53 (7.7)
4–6 months	454 (70.4)	Technicians/associate professionals	46 (6.7)
>6 months	42 (6.5)	Clerical support workers	45 (6.5)
Antibiotic exposure in first year	128 (18.6)	Service and sales workers	159 (23.1)
Personal allergic disease	102 (14.8)	Skilled agricultural workers	26 (3.8)
Asthma	39 (5.7)	Craft/trades workers	146 (21.1)
Allergic rhinitis	29 (4.2)	Plant/machine operators	43 (6.2)
Atopic dermatitis	38 (5.5)	Elementary occupations	127 (18.4)

† Percentages for age at solid food introduction were calculated among the 645 children who had started complementary feeding.

* Parental occupation was classified according to ISCO-08.

pea, one to cow's and goat's milk, and one to cow's milk and egg.

Exploratory associations with personal and family histories of allergic disease

In unadjusted exploratory comparisons, children with OFC-confirmed FA (n = 14) more frequently had a personal history of allergic disease (71.4% vs

13.6%) and a family history of atopic disease (92.9% vs 18.2%) than children without OFC-confirmed FA (n = 676). Asthma, allergic rhinitis, and atopic dermatitis, as well as family histories of these conditions, were also more frequent among children with OFC-confirmed FA (all P < 0.01; [Table 4](#)).

Table 2. Distribution of food allergies across successive diagnostic stages

Food	Lifetime report (n=44) n (%)	Current report (n=37) n (%)	Clinically suspected (n=25) n (%)	Sensitization- supported (n=19) n (%)	OFC-confirmed (n=17) n (%)
Cow's milk	15 (34.1)	11 (29.7)	11 (44.0)	8 (42.1)	7 (41.1)
Egg	7 (15.9)	4 (10.8)	4 (16.0)	3 (15.8)	3 (17.6)
Fish	4 (9.1)	4 (10.8)	2 (8.0)	1 (5.3)	2 (11.8)
Strawberry	4 (9.1)	4 (10.8)	0 (0.0)	0 (0.0)	0 (0.0)
Tomato	3 (6.8)	3 (8.1)	1 (4.0)	1 (5.3)	1 (5.9)
Non-peanut legumes*	2 (4.6)	2 (5.4)	2 (8.0)	2 (10.5)	2 (11.8)
Peanut	2 (4.6)	2 (5.4)	1 (4.0)	1 (5.3)	1 (5.9)
Tree nuts	1 (2.3)	1 (2.7)	0 (0.0)	0 (0.0)	0 (0.0)
Goat's milk	1 (2.3)	1 (2.7)	1 (4.0)	1 (5.3)	1 (5.9)
Beef	1 (2.3)	1 (2.7)	1 (4.0)	1 (5.3)	0 (0.0)
Chicken	1 (2.3)	1 (2.7)	1 (4.0)	0 (0.0)	0 (0.0)
Potato	1 (2.3)	1 (2.7)	1 (4.0)	1 (5.3)	0 (0.0)
Orange	1 (2.3)	1 (2.7)	0 (0.0)	0 (0.0)	0 (0.0)
Commercial orange juice	1 (2.3)	1 (2.7)	0 (0.0)	0 (0.0)	0 (0.0)

Values are n (%), calculated using the total number of food allergies at each stage. * Lentil and pea.

Sensitization-supported FA required a compatible history and a positive SPT and/or sIgE result.

FA, food allergy; OFC, oral food challenge; sIgE, serum-specific IgE; SPT, skin prick test.

Figure 2. Population prevalence of OFC-confirmed food allergy by culprit food.

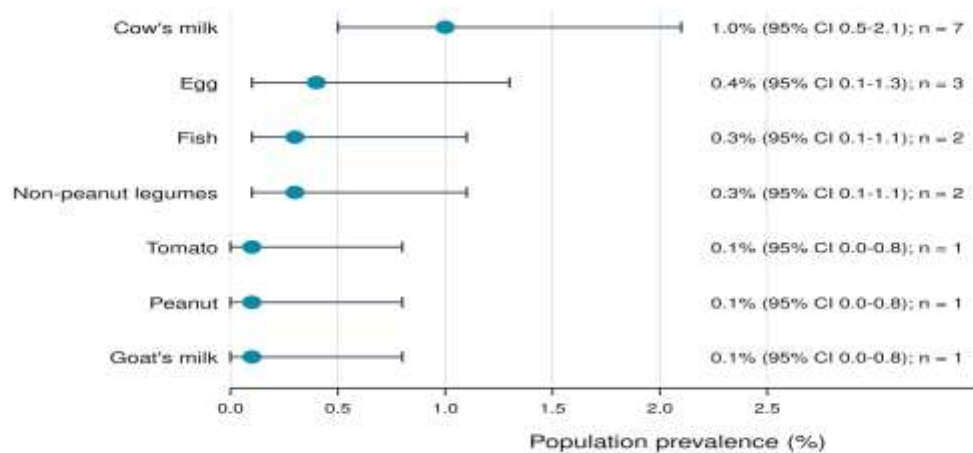


Table 3. Clinical characteristics of children with OFC-confirmed food allergy

Patient	Age (months)	Sex	Food	Clinical phenotype*	SPT (mm)	slgE (kUA/L)
1	4.5	M	Cow's milk	IgE-mediated: anaphylaxis	5	2.06
2	6	M	Cow's milk	Non-IgE-mediated: FPE	0	< 0.1
3	36	M	Cow's milk	IgE-mediated: anaphylaxis	9	22.10
3	36	M	Egg	IgE-mediated: urticaria	6	11.58
4	31	M	Egg	IgE-mediated: urticaria	8	13.10
5	9	F	Cow's milk	Non-IgE-mediated: acute FPIES	0	< 0.1
6	10.5	M	Cow's milk	IgE-mediated: anaphylaxis	10	14.00
7	11	M	Cow's milk	IgE-mediated: urticaria	8	6.07
8	41	M	Lentil	IgE-mediated: anaphylaxis	14	20.12
8	41	M	Pea	IgE-mediated: anaphylaxis	7	13.26
9	9.5	F	Egg	Mixed: atopic dermatitis	8	8.35
10	21	M	Whiting	Non-IgE-mediated: acute FPIES	0	< 0.1
11	46	M	Cow's milk	IgE-mediated: urticaria	10	16.08
11	46	M	Goat's milk	IgE-mediated: urticaria	8	-
12	55	M	Peanut	IgE-mediated: PFAS	7	7.56
13	47	M	Sardine	IgE-mediated: anaphylaxis	15	29.40
14	54	F	Tomato	IgE-mediated: PFAS	7	4.32

All OFCs were positive. * FPE, food protein-induced enteropathy; FPIES, food protein-induced enterocolitis syndrome; PFAS, pollen-food allergy syndrome. SPT, skin prick test; slgE, serum-specific IgE; OFC, oral food challenge.

Table 4. Personal and family allergic histories by OFC-confirmed food allergy status

Characteristic	Without OFC-confirmed FA (n=676) n (%)	With OFC-confirmed FA (n=14) n (%)	P value*
Any personal allergic disease	92 (13.6)	10 (71.4)	< 0.001
Asthma	34 (5.0)	5 (35.7)	< 0.001
Allergic rhinitis	25 (3.7)	4 (28.6)	0.002
Atopic dermatitis	31 (4.6)	7 (50.0)	< 0.001
Any family history of atopic disease	123 (18.2)	13 (92.9)	< 0.001
Asthma	50 (7.4)	6 (42.9)	< 0.001
Allergic rhinitis	69 (10.2)	8 (57.1)	< 0.001
Atopic dermatitis	4 (0.6)	3 (21.4)	< 0.001
Food allergy	24 (3.6)	4 (28.6)	0.002

* Fisher exact test. FA, food allergy; OFC, oral food challenge

Discussion

To our knowledge, this is the first population-based study to estimate FA prevalence among children younger than 5 years in an Algerian municipality using a standardized diagnostic pathway culminating in OFC. The principal finding was the marked decline in prevalence across increasingly stringent diagnostic stages, from 5.9% based on lifetime parental report to 2.0% after OFC confirmation. Cow's milk and egg were the leading allergens, whereas the overall culprit-food distribution, including the prominence of fish and legumes, reflected regional dietary patterns. Children with OFC-confirmed FA also had higher frequencies of personal and familial atopy, although these associations should be interpreted cautiously given the small number of confirmed cases.

The population-based sampling design and high participation rate support the representativeness of the sample within the municipality of Beni Messous. However, the estimates should not be extrapolated to the wider Algerian pediatric population.

The progressive reduction in estimated FA prevalence according to the diagnostic method is one of the most informative findings of this study. Lifetime parent-reported FA was 5.9% and decreased to 4.9% after resolved cases were excluded. It was further reduced to 3.2% following a standardized allergy-focused assessment, to 2.3% when a compatible clinical history was considered together with evidence of sensitization, and finally to 2.0% after OFC confirmation. A similar discrepancy has been observed in South Africa, where parent-reported FA prevalence was 7.4% compared with 2.5% after OFC confirmation, and in China, where the corresponding estimates were 9.3% and 3.8% (21-22). These findings illustrate the limited specificity of questionnaire-based estimates and the risk of misclassifying non-allergic adverse food reactions as FA.

SPTs and serum-specific IgE improve diagnostic assessment but demonstrate sensitization rather than clinical allergy and must therefore be interpreted in the context of a compatible history (23-24). Conversely, a strategy based exclusively on IgE sensitization may fail to identify non-IgE-mediated disease, which accounted for 0.4% of our study population. The relatively small difference between the prevalence supported by clinical history and sensitization (2.3%) and that confirmed by OFC (2.0%) suggests that structured allergological assessment can achieve good diagnostic discrimination. Nevertheless, OFC remains the reference standard when uncertainty persists and is particularly important in

epidemiological studies seeking to avoid prevalence overestimation (15-16, 18, 23-24).

The OFC-confirmed FA prevalence of 2.0% (95% CI 1.2-3.4) lies within the range reported internationally (1, 9-10). It was comparable to estimates from South Africa and the EuroPrevall birth cohort (21, 25-26), but lower than those reported in Ireland and Australia (27-30). Direct comparisons should be made cautiously because of differences in age distribution, dietary exposure, study period, sampling procedures, diagnostic definitions, and challenge protocols. FA was more frequent among boys and children younger than 2 years, but neither difference was statistically significant. These observations are descriptive, although their direction is consistent with reports of male predominance during early childhood and declining prevalence with age, particularly as cow's milk and egg allergy resolve (28-33).

Cow's milk and egg were the leading allergens, in agreement with studies identifying them as the predominant causes of FA during early childhood (22, 28, 34). Cow's milk allergy was more frequent than egg allergy in our population, with respective prevalence estimates of 1.0% and 0.4%. A similar distribution has recently been reported in Israel, where cow's milk allergy (1.0%) also exceeded egg allergy (0.8%) (35). Fish and non-peanut legumes were the next most frequent allergens. Sardine and whiting were the principal fish species involved, probably reflecting their frequent consumption in Algeria. Fish, particularly hake, is likewise an important allergen among young children in Spain (36-37). Lentil and pea accounted for most legume allergies in our cohort, consistent with observations from Mediterranean countries, where these foods are widely consumed and are recognized causes of childhood FA (4, 38-39). This pattern differs from that reported in Northern Europe and North America, where peanut is relatively more prominent (4, 8-9, 34, 40), and highlights the influence of regional dietary practices on allergen distribution.

IgE-mediated FA was the predominant phenotype, with an estimated prevalence of 1.5%, whereas non-IgE-mediated and mixed forms were less frequent. Five children had experienced food-induced anaphylaxis, corresponding to a population prevalence of 0.7% (95% CI 0.3-1.7), with cow's milk, lentil, and fish identified as triggers. Western data from Europe, the United States, and Australia identify peanut and tree nuts as major triggers of pediatric food-induced anaphylaxis. However, this predominance is age dependent: cow's milk and hen's egg are more prominent during infancy and early toddlerhood, whereas peanut becomes the leading trigger after 3 years in the European Anaphylaxis Registry; in US national pediatric emergency-department data, peanut was the leading trigger overall, while a

study restricted to children younger than 5 years found egg to be the most frequent trigger in infants (2, 4, 37, 39-46). In contrast, our age-specific pattern—cow's milk in infants and cow's milk, fish, and lentil in older preschool children, resembles reports from Mediterranean and East Mediterranean settings, where habitual early exposure to fish and non-peanut legumes, particularly lentil, influences the distribution of culprit foods (4, 31, 36-39). Nevertheless, the small number of events and wide confidence interval preclude firm conclusions regarding the burden or distribution of food-induced anaphylaxis in the wider population. PFAS, another IgE-mediated phenotype, was identified in two preschool children. Both were sensitized to Phl p 12, a finding compatible with profilin-mediated cross-reactivity, although the small number of cases does not allow broader inference (47-48).

Non-IgE-mediated and mixed phenotypes were uncommon. Cow's milk and whitening were the FPIES triggers, consistent with Mediterranean series in which milk and fish are among the leading causative foods (49-51). Mixed FA was identified in one child with egg-associated atopic dermatitis. OFC confirmed egg allergy in only one of the three children evaluated for suspected food-related atopic dermatitis. This is consistent with evidence that sensitization is common in atopic dermatitis but does not necessarily indicate clinically relevant FA, reinforcing the need for careful clinical correlation and, when appropriate, challenge confirmation (52).

Personal and familial atopy were more frequent among children with OFC-confirmed FA. Similar relationships have been reported in the HealthNuts and EuroPrevall cohorts (53-54), and a recent systematic review identified personal allergic disease, particularly atopic dermatitis, and family history of allergy among the most consistent predictors of childhood FA (55). However, our study was neither designed nor sufficiently powered to identify independent risk factors. These findings should therefore be interpreted as exploratory and require confirmation in larger analytical studies with multivariable adjustment.

This study has several strengths. Its population-based design, high participation rate, standardized allergy-focused assessment, and systematic use of OFC in children with suspected FA reduce diagnostic misclassification and provide data from a region where challenge-confirmed prevalence estimates remain scarce. Several limitations should nevertheless be acknowledged. First, the survey was conducted in a single municipality, limiting generalizability to other Algerian regions. Second, replacement of households that declined participation or were unavailable, or did not include an eligible child may have introduced selection bias. Third, the small number of

confirmed cases resulted in imprecise estimates for individual allergens, clinical phenotypes, and associated factors. Fourth, data were collected in early 2020 and may not fully reflect subsequent changes in infant feeding practices, dietary exposure, or FA prevalence. Finally, although open OFCs are widely used in clinical practice and pediatric epidemiological studies, double-blind, placebo-controlled food challenges remain the most rigorous reference method, particularly when symptoms are subjective.

In conclusion, this population-based study provides the first challenge-confirmed estimate of FA among children younger than 5 years in an Algerian municipality. Prevalence decreased from 5.9% by lifetime parental report to 2.0% after OFC confirmation, demonstrating the substantial overestimation resulting from reliance on reported symptoms or sensitization alone. Cow's milk and egg were the leading allergens, while fish and legumes reflected regional food exposure. These findings contribute evidence from Algeria to the limited North African literature and support larger, multicenter, nationally representative studies using standardized diagnostic criteria.

Conflict of interests

The authors declare no conflicts of interest.

Author contributions

LS: Conceptualization, Methodology, Investigation, Data curation, Formal analysis, Project administration, Visualization, Writing – original draft, Writing – review & editing. LLM, BB, IA and RD: Investigation, Resources, Validation, Writing – review & editing. GB, NS, and YL: Methodology, Formal analysis, Writing – review & editing. KN: Investigation, Visualization, Writing – review & editing. NB: Conceptualization, Investigation, Supervision, Writing – review & editing. RB: Supervision, Writing – review & editing.

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