

Epidemiological and clinical aspects of food allergy in the pediatric population of western Algeria

Aspects épidémiologiques et cliniques de l'allergie alimentaire dans la population pédiatrique de l'Ouest algérien

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ABSTRACT

Background: The prevalence of food allergies has increased over recent decades; however, little is known about this issue in Algeria. **Aim:** This study aimed to assess the prevalence of food allergies in the urban area of Sidi-Bel-Abbès (western Algeria) and to describe their epidemiological and clinical features. **Methods:** A cross-sectional study was conducted among 1,000 children aged 0-15 years, recruited from the Pediatric Department of the University Hospital Center of Sidi-Bel-Abbès. **Results:** The overall prevalence of food allergies was 2.6%. A statistically significant difference was observed between age groups ($p = 0.019$), with infants showing the highest prevalence (8.3%), which gradually decreased with age, reaching 1.5% among adolescents. Gender did not significantly influence the prevalence of food allergy (Male= 2.8% vs Female= 2.4%, $p = 0.52$). Clinical manifestations varied by age: atopic dermatitis was primarily observed in infants, while anaphylactic shocks and angioedema were more common in adolescence. The distribution of food allergens also varied with age: animal-derived allergens (cow's milk: 30.8%, egg: 11.5%, fish: 3.8%) were more common in younger children, while plant-derived allergens (Poaceae: 11.5%, Rosaceae: 15.4%, Leguminosae: 7.7%, Latex-fruit group: 3.8%, Apiaceae: 7.7%, Solanaceae: 3.8%, Nut group: 3.8%) predominated in adolescents. Several factors were significantly associated with food allergy including a family history of atopy ($p = 0.03$), pollen allergy ($p = 0.041$), delayed food diversification ($p = 0.023$), and presence of asthma ($p = 0.009$). **Conclusion:** This study provided updated epidemiological data on food allergies in children in western Algeria, highlighting age-related variability in prevalence and clinical presentation.

Keywords: Food allergy, Children, Prevalence, Epidemiology, Algeria

INTRODUCTION

A food allergy, as defined by the National Institute of Allergy and Infectious Diseases (NIAID)-sponsored expert panel, is an adverse health effect resulting from a specific, reproducible immune response after exposure to a food. This definition includes both IgE-mediated reactions (like anaphylaxis) and non-IgE-mediated reactions, differentiating it from food intolerances, which are not caused by an immune response. The triggering foods may be raw, processed, or include additives and supplements [1].

Food allergy has become a major public health concern due to its increasing prevalence particularly among children, and its potential severity, which can lead to serious or even fatal reactions. Moreover, this condition significantly affects the quality of life of both children and their families, having substantial nutritional, psychological, social, and economic repercussions [2].

Over recent decades, the incidence of food allergy has steadily increased worldwide [3,4] and in Algeria [5,6], with a growing number of patients being referred for diagnosis and management. However, despite the potentially life-threatening consequences of food allergies, especially in

children, research on this topic at the national level remains limited.

In this context, the present study aimed to assess the prevalence of food allergies in the pediatric population of the urban area of Sidi-Bel-Abbès (western Algeria) and to describe their epidemiological and clinical features.

PATIENTS & METHODS

Study design and participants

A cross-sectional survey was carried out from 13 December 2023 to 31 January 2024, using a questionnaire. Direct interviews were performed with parents of children attending medical consultations at the Pediatric Department of the University Hospital Center of Sidi-Bel-Abbès (western Algeria). Eligible participants included newborns, infants, children, and adolescents aged 0-15 years, residing in the Sidi-Bel-Abbès urban area, whose parents provided informed consent to participate in the survey. Participation was anonymous and voluntary.

Based on previous research, the prevalence of food allergies in the Algerian pediatric population was estimated at 2.13 % [5]. With an absolute margin of error of 1% and a 95% confidence level, the Raosoft online calculator [7] indicated a minimum sample size of 801 participants.

Stratified random sampling according to age groups was utilized to select 1000 participants: 0-4 years (27.3%), 5-9 years (22.1%), 10-14 years (24.6%), and ≥ 15 years (26%) based on the most recent statistics of the Algerian National Statistics Office [8]. Stratified random sampling helps ensure that the sample accurately reflects the population, allowing more precise conclusions to be drawn about the target population.

For specific pediatric subgroup analyses, age was further categorized based on completed years at the time of inclusion: 0-1 year (< 2 years), 2-5 years (2 to < 6 years), 6-11 years (6 to < 12 years), and 12-15 years (12 to < 16 years), in order to facilitate comparability with published literature.

Diagnosis was verified through review of medical records, clinical evaluation, skin prick tests and specific serum IgE measurements when available. Oral food challenges were not systematically performed because of logistical and ethical constraints.

Food intolerances (such as enzymatic lactase deficiency) and pseudo-allergic reactions (caused by foods rich in histamine or histamine-liberating substances) were excluded after review of medical records and clinical history by the attending pediatric allergist.

Questionnaire

The questionnaire in the survey was divided into three distinct sections. The first section collected sociodemographic information such as: gender, age, etc. The second section focused on food allergies, including their presence or absence, identification of causative foods, and associated clinical manifestations. The third section addressed factors associated with food allergies like: age at food diversification, presence of other allergic conditions (e.g., aeroallergens), family history of atopy, and the presence of asthma. The questionnaire was used for data collection only; prevalence estimates were based on medically confirmed food allergy cases rather than parental suspicion. Aeroallergen allergy was based on documented diagnoses

and allergy investigations recorded in medical files, including skin prick testing when available, performed in children with respiratory allergy symptoms.

To ensure the validity and reliability of the questionnaire, a pilot study was conducted on a sample of 30 subjects. Final questionnaire was refined based on the recommendations and suggestions provided by an epidemiologist.

Statistical analysis

Data were analyzed using the Statistical Package for Social Sciences (SPSS) version 22.0. Quantitative variables were expressed as means $\pm$ standard deviation (SD) and qualitative variables as percentages. Pearson Chi-square test was used to examine differences involving categorical variables. A p-value of less than 0.05 was considered statistically significant.

RESULTS

Population Characteristics

The study included 1,000 children aged from 0 to 15 years. The age distribution of the study population is illustrated in Table 1. The predominant age groups were adolescents (12-15 years), representing 38.4%, and preschool-aged children (2-5 years), accounting for 29.7%, followed by school-aged children (6-11 years) at 27.1%. Infants and newborns represented only 4.8% of the study population. The gender distribution in this sample was relatively balanced, with a sex ratio of 1.14.

Prevalence of Food Allergy

Table 1 presents the prevalence of food allergy among children according to age group. The overall prevalence of food allergy in the study population was 2.6%. A statistically significant difference was observed in the prevalence of food allergies between age groups ($p = 0.019$). Children aged 0-1 year showed the highest prevalence of food allergies (8.3%), which gradually decreased with age, reaching 1.5% among adolescents aged 12-15 years. The prevalence of food allergy was slightly higher in males (2.8%) than in females (2.4%), but this difference was not statistically significant ($p = 0.52$).

Table 1. Prevalences of food allergy among the children according to age groups

Age groups	Overall population (n=1000)		Food allergy (n=26)		P-value
	n	%	n	%	
0-1 year	48	4.8	4	8.3	0.019 *
2-5 years	297	29.7	11	3.7	
6-11 years	271	27.1	5	1.8	
12-15 years	384	38.4	6	1.5	
Total	1000	100	26	2.6	

* Pearson Chi-square test, $p < 0.05$

Relative Frequencies of Major Allergenic Foods

Table 2 presents the classification of foods involved in food allergy according to their origin and family. Among the 26 children diagnosed with food allergy, the causative foods were derived from both animal and plant sources. Animal-derived allergens accounted for 46.2% of cases, namely

cow's milk (30.8%), eggs (11.5%) and fish (3.8%). Cow's milk was the most commonly implicated allergen, accounting for nearly one-third of cases.

Among the plant-derived allergens, Rosaceae (Strawberry, 15.4%) and Poaceae (Wheat, maize, 11.5%) were most commonly involved. Other allergens included: Leguminosae

(Peanut, 7.7%), Latex-fruit group (Kiwi, 3.8%), Apiaceae (Celery, 7.7%), Solanaceae (tomato, 3.8%) and the nut group

(Pistachio, 3.8%). Most children were allergic to a single food item, whereas multiple food allergies were less common.

Table 2. Classification of foods involved in food allergy according to their origin and family

Origin and family	Foods	n (total=26)	%
Plant origin			53.8
Poaceae	Wheat, maize	3	11.5
Rosaceae	Strawberry	4	15.4
Leguminosae (Fabaceae)	Peanut	2	7.7
Apiaceae	Celery	2	7.7
Solanaceae	Tomato	1	3.8
Nut group	Pistachio	1	3.8
Latex-fruit group	Kiwi	1	3.8
Animal origin			46.2
	Cow's milk	8	30.8
	Eggs	3	11.5
	Fish	1	3.8

Age-Related Variations in Allergenic Food Groups

Figure 1 illustrates the distribution of food allergy cases (absolute numbers) according to age group and allergenic

food category. It shows that the number of cow's milk and egg allergy cases decreases with age, whereas allergies to Rosaceae fruits, Apiaceae, the latex-fruit group, peanuts, and nuts appear more frequently in older children.

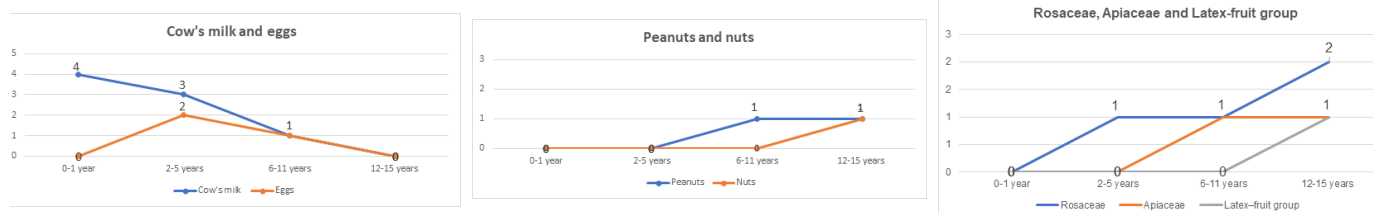


Figure 1. Distribution of food allergy cases (absolute numbers) according to age group and allergenic food category.

Age-Related Evolution of Major Clinical Manifestations

Figure 2 presents the age-related evolution of the main clinical manifestations. Atopic dermatitis was predominantly observed in infancy, representing the main manifestation

among children aged 0-1 year. In contrast, anaphylactic shock (n=2) and angioedema were relatively rare among younger children but became more frequent from adolescence onward.

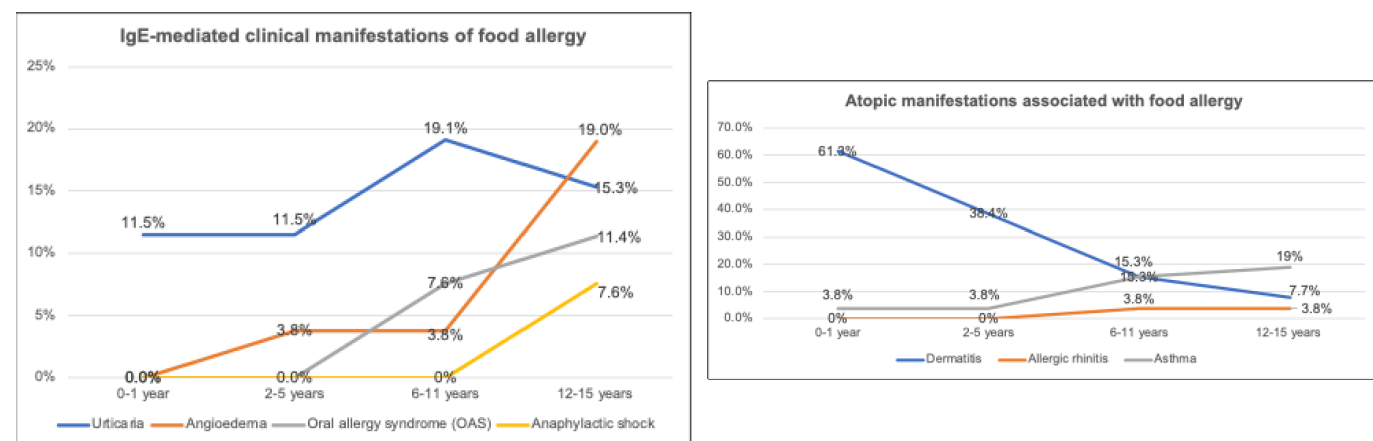


Figure 2. Age-related evolution of the main clinical manifestations: (a) IgE-mediated clinical manifestations; (b) atopic manifestations associated with food allergy.

Factors Associated with Food Allergy

In this study, we examined the association between food allergy and several clinical and demographic variables, including: age at food diversification, presence of other types of allergies (aeroallergens), family history of atopy and presence of asthma.

Food Allergy and Aeroallergens

Pollen allergy was reported in 26.9% (7/26) of children with food allergy, compared with 13.2% (129/974) of those without food allergy. A statistically significant association was observed between food allergy and pollen allergy ($p = 0.041$). In contrast, dust mite allergy was found in 23.1% (6/26) of children with food allergy and 11.8% (115/974) of

those without food allergy, while mold allergy was reported in 23.1% (6/26) and 11.9% (116/974) of children, respectively. Neither dust mite allergy ($p = 0.083$) nor mold allergy ($p = 0.084$) showed a statistically significant association with food allergy.

Food Allergy and Family History of Atopy

A family history of atopy was reported in 12 of the 26 children with food allergy (46.2%), compared with 269 of the 974 children without food allergy (27.6%). Statistical analysis revealed a significant association between food allergy and family history of atopy ($p = 0.03$).

Food Allergy and Age at Food Diversification

Delayed food diversification (after 6 months of age) was observed in 12 of the 26 children with food allergy (46.2%), compared with 261 of the 974 children without food allergy (26.8%). Delayed food diversification was significantly associated with food allergy ($p = 0.023$).

Food Allergy and Asthma

Among the 26 children with food allergy, 3 (11.5%) also had asthma. In contrast, asthma was reported in 27 of the 974 children without food allergy (2.7%). A significant association was found between food allergy and asthma ($p = 0.009$).

DISCUSSION

This descriptive study conducted in the urban area of Sidi-Bel-Abbès, involving 1,000 children aged 0-15 years, estimated a food allergy prevalence of 2.6% based on medically confirmed cases verified through medical records and allergological investigations. This prevalence is comparable to that reported in other Algerian cities [5,6]. The increasing prevalence of food allergies may be attributed to several factors, including increased awareness and vigilance among healthcare professionals, leading to more frequent diagnoses, environmental changes (notably the "hygiene hypothesis"), alterations in the allergenicity of foods during industrial processing, increased maternal employment, often associated with a decline in breastfeeding, whose protective effects are well recognized, and globalization leading to greater availability of diverse foods for consumers such as Kiwi and sesame [9,10].

In terms of allergen distribution, the main allergens identified in this study were of both animal origin (cow's milk, egg, fish) and plant origin (fruits such as kiwi and strawberry, cereals, peanuts, vegetables, and tree nuts) (Table 2). These findings are consistent with those of previous studies [5,11], although geographic, climatic, and dietary differences exert a significant influence on the list of predominant allergens in each region.

Furthermore, our findings suggest that the types of food allergens might differ by age: animal-derived allergens were more frequent among younger children, whereas plant-derived allergens predominated in adolescents (Fig. 1). However, given the limited number of food-allergic children included in the study, these findings should be interpreted

with caution and considered descriptive rather than conclusive.

Despite these limitations, the observed age-related distribution of food allergens aligns closely with the existing literature [11,12], as well as with data from the Allergy Vigilance Network® [13] and the PRONUTS study [14]. However, interpretation should remain cautious because of the limited number of food-allergic children and the absence of systematic classification of allergy type.

Over time, there has been an increase in poly-allergies and poly-sensitizations, alongside the emergence of new allergens such as sesame, nuts, and pine nuts [15].

With regard to clinical manifestations, our findings revealed age-related variations in symptom presentation. Atopic dermatitis remained primarily an infantile manifestation, while anaphylactic shock and angioedema, relatively rare in early childhood, became more frequent during adolescence (Fig. 2). These observations are well supported by the literature. In early childhood, cutaneous manifestations are the most common. Acute urticaria, frequently observed, is linked to a type I IgE-mediated mechanism. Atopic dermatitis is often linked to food sensitization especially in young children; however clinically relevant food allergy is only found in a small number of patients and food allergy should not be considered a main cause of atopic dermatitis in most cases.

Angioedema is a subcutaneous edema of variable extent that becomes serious when it involves the larynx. Other mucocutaneous manifestations may also occur, such as the Lessof oral allergy syndrome (itching and edema of the lips, gingiva, or oral mucosa, and occasionally laryngeal edema), rhinitis (nasal obstruction, itching, coughing, sneezing, conjunctivitis), and respiratory symptoms such as bronchial asthma. The most severe manifestation remains anaphylactic shock, characterized by acute circulatory failure caused by primary peripheral vasodilation secondary to the massive release of mediators, which may be life-threatening [16].

Beyond clinical manifestations, several factors were significantly associated with food allergy in this study. A family history of atopy was observed in 46.2% of affected children, confirming the well-documented genetic predisposition. The CICBAA (Clinical and Biological Investigations Circle for Food Allergy) database confirms this observation [17].

In addition, pollen allergy was also significantly associated with food allergy ($p = 0.041$), consistent with the literature reporting cross-reactivity between pollen and certain fruits and vegetables via shared allergenic proteins such as profilins and PR-10 proteins, consequently, patients allergic to pollens have an estimated 55% risk of also being allergic to certain fruits and vegetables [18,19]. The use of recombinant allergens in diagnostics is valuable to distinguish true food allergies from cross-sensitization, guiding effective elimination diets [20].

Delayed food diversification (introduction of solid foods after 6 months) was significantly associated with food allergy ($p = 0.023$). However, literature regarding complementary feeding timing and allergic diseases remains inconsistent [21]. Current European guidelines define early complementary feeding as the introduction of solid foods before 4 months of age, and late complementary feeding as introduction after 6 months [22].

Earlier studies have shown that introducing solid foods too early exposes infants to a wider variety of potential allergens. A study involving over 1,000 infants without specific risk factors – except for early diversification (introduction of more than four foods before 4 months) – found that early diversification tripled the risk of eczema development [23]. Conversely, several large cohort studies involving more than 20,000 infants have shown that delaying the introduction of foods has no significant protective effect and may even increase the risk of eczema, asthma, allergic rhinitis, or sensitization, including food allergies [24-26].

More recently, a large epidemiological study from the ELFE cohort demonstrated a clear association between delayed food diversification and an increased risk of developing food allergies. The study highlighted the elevated risk of food allergy associated with delayed introduction of major allergenic foods [21].

Collectively these findings confirm the importance of not delaying the introduction of major allergenic foods in order to prevent allergic diseases during childhood. Consequently, European pediatric guidelines now recommend introducing allergenic foods concurrently with other solids between 4 and 6 months of age for healthy infants [22,27]. Nevertheless, the World Health Organization (WHO) continues to advocate for exclusive breastfeeding up to 6 months [28].

Finally, food allergy was significantly associated with asthma ($p = 0.009$). Several studies have demonstrated that food

allergy associated with atopic dermatitis often precedes the onset of asthma and/or allergic rhinitis, as well as sensitization to aeroallergens. Thus, early food allergy may represent a risk factor for the subsequent development of asthma [18].

LIMITATIONS

The current study has several limitations that should be stated. The data were collected via interviews, which could introduce recall bias or social desirability bias. Moreover, the diagnosis of food allergy was based on clinical history and available tests, without systematic confirmatory testing for all participants. In addition, pseudo-allergic reactions were excluded based on clinical assessment and record review; however, systematic oral food challenge testing was not performed, which may have led to some misclassification.

CONCLUSION

Food allergy in children is a growing public health concern. This study highlights its prevalence by examining the clinical and epidemiological characteristics of children aged 0-15 years in the urban area of Sidi-Bel-Abbès (Algeria). The findings emphasize the importance of early diagnosis, preventive strategies, particularly regarding the timing of food diversification and continuing education for healthcare providers and families to help reduce the burden of pediatric food allergies.

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