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Original article

Contribution to the estimation of the prevalence of food allergy in schoolchildren in the city of Guelma (Algeria)

Contribution à l'estimation de la prévalence de l'allergie alimentaire chez les écoliers de la ville de Guelma (Algérie)

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ARTICLE INFO

Article history:

Received 6 March 2021

Accepted 22 June 2021

Available online xxx

Keywords:

Food allergy

Prevalence

Schoolchildren

Cross sectional study

Epidemiology

Algeria

ABSTRACT

Goal. – The prevalence of food allergy has never been estimated in the city of Guelma (east Algeria). The goal in this work was to determine parent-reported prevalence of food allergy in a population of schoolchildren (5 to 13 years old).

Methods. – Cross-sectional, random, questionnaire based survey was performed from 15th to 29th April 2018 among primary schools of Guelma. Six hundreds questionnaires were distributed in 8 schools of the city.

Results. – The return rate was 88% (528). Forty-five subjects were retained as having probable food allergy at a prevalence of 8.5% (95% CI 6.1–10.8). In total, 49% were boys and 51% girls with no significant difference ($P=0.429$). The average age of appearance of the potential allergy was 4.41 ± 2.51 years. Among allergic children, 26.7% were aged from 5–7 years old, 64.4% had 8–10 years old and 8.9% had 11–13 years old. The main foods reported by the parents were: chocolate (1.7%), wheat (1.3%), milk (1.1%), eggs (1.1%), strawberry (1.1%), fish and beans (0.9%). The prevalence of the three symptoms according to the observations of the parents were cutaneous (68.6%), digestive (19.6%) and respiratory (11.8%). Among the allergic subjects, 66.6% had at least one of their parents atopic ($P=0.0001$).

Conclusion. – The prevalence of parent-reported food allergy in schoolchildren was assessed for the first time in the city of Guelma. It showed a prevalence of 8.5% with no significant difference between the boys and the girls. The main risk factor in the appearance of food allergy was the presence of family history with this pathology.

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R É S U M É

But. – La prévalence de l'allergie alimentaire n'a jamais été estimée dans la ville de Guelma (est de l'Algérie). Le but de ce travail était de déterminer la prévalence des allergies alimentaires déclarée par les parents dans une population d'écoliers (de 5 à 13 ans).

Méthode. – Une enquête transversale, aléatoire, basée sur un questionnaire a été réalisée du 15 au 29 avril 2018 dans les écoles primaires de Guelma. Au total, 600 questionnaires ont été distribués dans 8 écoles de la ville.

Mots clés :

Allergie alimentaire

Prévalence

Écoliers

Enquête transversale

Épidémiologie

Algérie

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<https://doi.org/10.1016/j.reval.2021.06.005>

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Résultats. – Le taux de retour était de 88 % (528). Quarante-cinq sujets ont été retenus comme ayant une allergie alimentaire probable, soit une prévalence de 8,5 % (IC à 95 % 6,1–10,8). Quarante-neuf pour cent étaient des garçons et 51 % des filles sans différence significative ($p=0,429$). L'âge moyen d'apparition de l'allergie potentielle était de $4,41 \pm 2,51$ ans. Parmi les enfants allergiques, 26,7 % étaient âgés de 5 à 7 ans, 64,4 % de 8 à 10 ans et 8,9 % de 11 à 13 ans. Les principaux aliments déclarés par les parents étaient : le chocolat (1,7 %), le blé (1,3 %), le lait (1,1 %), les œufs (1,1 %), la fraise (1,1 %), le poisson et les haricots (0,9 %). La prévalence des trois symptômes selon les observations des parents était cutanée (68,6 %), digestive (19,6 %) et respiratoire (11,8 %). Parmi les sujets allergiques, 66,6 % avaient au moins un de leurs parents atopique ($p=0,0001$).

Conclusion. – La prévalence des allergies alimentaires déclarées par les parents d'enfants scolarisés a été estimée à 8,5 %, sans différence significative entre les garçons et les filles. Le principal facteur de risque d'apparition de l'allergie alimentaire était la présence d'antécédents familiaux avec cette pathologie.

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1. Introduction

Little information on the prevalence of food allergies is available despite the efforts underway to provide reliable data [1]. A rigorous estimation of the prevalence of FA in a general population is starting by studying the history and the clinical symptoms and assessing allergic sensitization (skin prick tests, specific IgE dosage), and if any doubt, DBPCFC [2]. In order to make such a large-scale study using this approach may not be feasible. It takes a lot of time, money and effort which are not always available. Cross sectional studies are the best choice to examine the prevalence of some outcome at a certain moment in time. It can be used for both analytical and descriptive purposes [3]. This method is largely used for the estimation of food allergies' prevalence.

Facing the lack of information on the prevalence of food allergy and some fragmented studies available on this pathology in Algeria [4–6]; we conducted a cross sectional questionnaire based study in the primary schools of the city of Guelma, targeting children aged between 5 and 13 years old. The main goals of this research study are to overview the current state of food allergies in schoolchildren in the city of Guelma; to determine the prevalence of food allergy in this population, to highlight the most common foods causing allergy and finally to assess any correlation between this pathology and some of its risk factors.

2. Material and methods

In order to estimate the prevalence of food allergy in the schoolchildren in the town of Guelma, a cross sectional questionnaire based study was conducted in 8 different primary schools. The study was made from 15th to 29th April 2018.

2.1. Study design and population

Cross-sectional, random, questionnaire based survey was performed during the last 2 weeks of April 2018. Among 40 primary schools of the city, 8 schools (20%) accepted to participate in the study.

The sample size was calculated according to the method shown in the work of Charan and Biswas [7]. With a 95% confidence interval (95% CI), assuming the prevalence was 5% or less and 2% absolute error, the sample size calculated was 457 children. Anticipating a response less than 80%, 600 surveys were distributed. Children were randomly recruited from all grades (1st to 5th grade) in order to have all age categories. There was no direct contact between the recruited children and the researchers.

2.2. Questionnaire

The survey was approved by the evaluation office in the education department of Guelma. The survey was written in Arabic and was addressed to parents assuming that the targeted children are too young to answer by themselves.

A standard, anonymous questionnaire was distributed to gather personal data (gender and age). The first question to the parents was: "does your child have or ever had an allergic reaction to food?" If the answer was "Yes", the parents were asked to determine the food/foods causing the allergy because there was no pre-determined list of foods. For each food reported as causing an adverse reaction, the parents were asked to determine the age of the first reaction, the clinical signs, whether the allergy had persisted or had disappeared with the age of recovery and whether there was family history of allergy. The survey is provided as supplementary figure ([Online material Supplementary Fig. 1](#)).

2.3. Statistical analysis

The quantitative results are presented as median with interquartile range (IQR). The Chi2 test was used for comparisons between proportions and kruskal-wallis test was performed for comparison between means. The significance level was set at $P < 0.05$. The statistical analyses were performed using XLSTAT 2016 (version 1802.01.28451).

3. Results

3.1. General aspect of the results

In this cross-sectional questionnaire based study, 600 questionnaires were distributed randomly in 100 classes in eight different schools in the city of Guelma. The return rate was 88% (528).

The overall average age was 10.3 ± 8.6 years (5–13 years of age). There were 232 boys and 296 girls (sex ratio M/F 0.73). In total, 203 (38.4%) children had the age between 5–7 years, 290 (54.9%) children aged (8–10 years) and 35 (6.7%) children 11–13 years ([Table 1](#)).

From the 53 subjects reporting food allergy, 8 were excluded because of the absurd answers on the food section (food coloring and conservatives (4), street food (2), mortadella (1) and soda (1)).

3.2. Prevalence of food allergy

The prevalence of food allergies estimated according to the questionnaires was 8.5%, 45 answered yes (95% CI 6.1–10.8).

Table 1
Classification of children by age group, allergic subjects and recovery.

Age group (years)	Total number <i>n</i>	Gender		Allergic		Recovery	
		Girls	Boys	Number <i>n</i>	Percentage (<i>n/N</i>)	Number <i>n1</i>	Percentage (<i>n1/n</i>)
[5–7]	203	110	93	12	5.9	4	33.3
[8–10]	290	170	120	29	10	15	51.7
[11–13]	35	16	19	4	11.4	1	25.0
Total	528	296	232	45		20	

Table 2
Prevalence of foods causing food allergies.

Foods	Number	Percentage
Chocolate	9	1.7
Wheat	7	1.3
Milk	6	1.1
Egg	6	1.1
Strawberry	6	1.1
Fish ^a	5	0.9
Beans ^b	5	0.9
Sunflower seeds	3	0.5
Peanut	2	0.3
Potatoes	2	0.3
Green peas	2	0.3
Apple	2	0.3
Meat ^c	1	0.1
Beetroot	1	0.1
Peach	1	0.1
Tomatoes	1	0.1
Melon	1	0.1
Olive	1	0.1
Raspberry	1	0.1

^a Fish: the only type mentioned in the 5 cases was sardine.^b Beans regroup 4 children allergic to faba beans and one child allergic to green beans.^c Meat refers to beef.

3.2.1. Prevalence of food allergy by age group and gender

There were 12 (5.9%) children with food allergies in the first age group (5–7 years), 29 children (10%) allergic aged 8–10 years and 4 allergic children (11.4%) aged 11–13 years (Table 1).

From subjects answering “yes” to the allergy question: 51% (23) were girls and 49% (22) were boys. The prevalence of food allergy in girls was 7.7% (95% CI 4.6–10.7) and in boys 9.5% (95% CI 5.7–13.2). According to our study there is no significant influence of the gender on the appearance of allergy ($P=0.429$).

3.2.2. Prevalence of allergy by foods

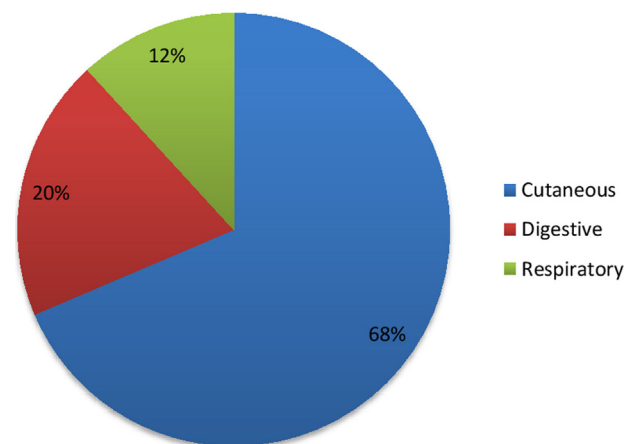
In total, 20 foods were cited 62 times. Chocolate was mentioned 9 times (1.7%), wheat 7 times (1.3%), milk, eggs and strawberries 6 times each (1.1%), fish and beans (faba beans and green beans) 5 times each (0.9%). Greater detail is provided in Table 2.

From the 45 children reported with food allergy: 34 had only one food allergy, 9 had two food allergies, 1 had three food allergies and 1 child had six food allergies.

Table 1 points out the number of children with food allergies and the number of recovery in every age group. The recovery was higher in children with the age of 8–10 years (15 children, 51.7%), followed by 33.3% of recovery in the group of age 5–7 years and at last 25% of recovery for children with the age 11–13 years. There is no significant difference between the percentage of recovery between the age groups ($P=0.178$).

3.3. Main clinical characteristics

The median age when the food allergies were detected was 4 years (with a range of 0–10 years). Twenty children (44.4%)

**Fig. 1.** Percentage of the three clinical symptoms appearing on children with food allergy.

mentioned that they outgrew their food allergy. The median age when the allergy disappeared was 6.5 (with a range of 1–11 years).

Table 3 shows the median age (range) of appearance and recovery of food allergy in the most common foods. Even though milk had the youngest age of appearance and recovery (1.2 and 2 years old respectively) among the other foods, the differences for both appearance and recovery were not statistically significant ($P=0.166$ and $P=0.325$ respectively). In the other hand, milk had the highest percentage of recovery (66.6%) compared to all other foods but no statistical significance ($P=0.714$).

The three clinical signs of allergy were cited 51 times. Cutaneous signs were mentioned 35 times (69%). It was the most frequent sign among the top 7 common foods except for wheat that caused digestive symptoms in most cases. Digestive signs were reported 10 times (19%). The respiratory symptoms were present in 6 cases (12%) (Fig. 1).

In some cases, children suffered from combined symptoms. Three children had cutaneous and respiratory issues at once. Two children had simultaneously cutaneous and digestive symptoms and one child had respiratory and digestive symptoms at the same time.

3.3.1. Clinical signs by food

Table 4 shows the clinical signs for the top 7 foods (chocolate, wheat, milk, egg, strawberry, fish, and beans). Cutaneous symptoms were dominant in all those foods except for wheat that had a higher percentage in digestive symptoms. Both strawberry and beans didn't cause any digestive problems while the allergy to eggs was exclusively cutaneous.

3.4. History of atopy in allergic children

In total, 66.6% of children with family history of food allergy turned to be allergic while only 5.7% of children without a family history had food allergy. The statistical study shows a positive

Table 3

Appearance and recovery of food allergy presented by median (age) and interquartile range IQR (7 most common foods).

Food	Number	Age of appearance median (range)	IQR	Percentage of recovery	IQR	Age of recovery median (range)
Chocolate	9	3.0 (1–7) ^a	2	33.3	3.5	6 (3–10)
Wheat	7	5.5 (4–7) ^b	1.5	42.8	0.5	6 (6–7)
Milk	6	1.2 (0–4) ^c	2.12	66.6	4.5	2 (1–10)
Egg	6	2.5 (1–4) ^d	1.5	60.0	3.5	10 (3–10)
Strawberry	6	5.0 (1–9) ^a	4.0	28.5	2.5	7.5 (5–10)
Fish	5	6.0 (3–8) ^d	1.25	60.0	0.5	10 (10–1)
Beans	5	3.0 (2–8) ^d	1.5	20.0	/	9.0 (/) ^e

^a Four subjects didn't mention the age of first reaction.^b Three subjects didn't mention the age of first reaction.^c Two subjects didn't mention the age of first reaction.^d One subject didn't mention the age of first reaction.^e Only one subject recovered.**Table 4**

Clinical signs of the top 7 most common foods.

Food	Cutaneous (%)	Digestive (%)	Respiratory (%)
Chocolate	77.8	11.1	11.1
Wheat	25	62.5	12.5
Berries	87.5	0	12.5
Milk	83.3	16.7	0
Egg	100	0	0
Fish	86.6	0	16.7
Beans	60	20	20

relation between the family history and the appearance of food allergy in children ($P=0.0001$).

4. Discussion

In the present work, we conducted for the first time a cross-sectional study of the prevalence of food allergy in schoolchildren in the city of Guelma (Algeria). In our study, we examined food allergies without focusing on a single food in children aged from 5–13 years. The prevalence of parent-reported food allergy was estimated at 8.5% (95% CI 6.1–10.8).

4.1. Similarities of prevalence with previous studies

In Africa, children aged between 5 and 16 years old from 9 Ghanaian schools were recruited after getting parental consent to participate in the study. Adverse reactions and food consumption were determined by a questionnaire and atopy by skin prick testing (SPT) to peanut and 6 fruits. The prevalence of reported adverse reactions assessed by the questionnaire in the Ghanaian schoolchildren was 11.0% and 5% showed a positive SPT reaction [8]. In France, a cross-sectional, descriptive, questionnaire-based survey conducted in Toulouse (France) schools showed that the cumulative prevalence of food allergy in schoolchildren (2–14 years old) was 6.7% (95% CI) 5.8–7.6 [9]. In European, a study aimed to determine the prevalence of self-reported food allergy, food sensitization, probable food allergy (symptoms plus IgE sensitization), and challenge-confirmed food allergy in European school-age children. The prevalence of self-reported food allergy ranged from 6.5% in Athens to 24.6% in Lodz showing large geographical differences in the prevalence of food allergy in school-age children across Europe [10].

The previous prevalences of food allergy from an African country (Ghana) and European countries are showing some similarities to the prevalence found in our study.

In the question about the allergy, we aimed to know current and outgrown allergies. After dividing the cases into 3 age categories,

we expected that the prevalence of food allergy decreases with the age coupled with an increase in the prevalence of recovery, however the prevalence of recovery of the last category [11–13 years] dropped. We suppose that the recovery of food allergy reaches the maximum before 11 years old. We might suggest that, compared with younger children, the adolescents have persistent, possibly long life food allergies.

4.2. Risk factors influencing food allergy

According to our results the prevalence between girls and boys was not significantly different. In contrast, a review about the gender aspects in food allergy mentioned that gender differences likely play a role in food allergy development. Boys are more prone to have allergies before puberty whereas in adulthood women are more likely to have allergies [11]. In the other hand, the family history appeared to be the main risk factor influencing the appearance of food allergy in children (66.6% of the allergic children have a family background with the pathology). Similar results were found in other studies showing that family history is known to be one of the main factors in the appearance of food allergy [4,5].

While most studies focus on one food, our study gathered information about food allergy in the population of schoolchildren despite the food. Many reports on food allergies confirmed the relation between geographical region and the foods responsible for the allergy [10,12,13]. Some studies reported that atopy prevalence is higher in urban children than rural children [14,15]. Knowing that the population studied in our survey was urban, this factor can have an impact on our results.

4.3. Foods declared in food allergic children

Chocolate was found to be the most common food causing allergy to children in our study (1.7%). Nevertheless of the absence of evidence of food allergy to chocolate, according to the study in Salvadoran Schoolchildren, the prevalence of self-reported chocolate/cocoa allergy is 0.5% to 0.7% in selected populations [16]. Some

studies are suggesting that chocolate or cocoa allergy is a result of cross-contamination from some allergens such as: milk, tree nuts or peanuts [17]. The fact that chocolate may contain different allergens at once could explain its high prevalence. In addition to that, chocolate is considered to be a food that contains histamine releasers, when consumed it can cause pseudo-allergic reactions [18].

Milk, eggs, wheat and fish are known to be part of the most common causes of food allergies worldwide in children [19]. This suggestion was confirmed in our results where these foods were in the top eight allergy reasons with different prevalences.

The allergy to wheat affected 1.3% of the studied population. Knowing that wheat is associated to multiple disorders like: IgE mediated wheat allergy, non IgE mediated wheat allergy and celiac disease; it could explain the high prevalence of this allergy.

In a study on the risks of wheat allergy and early exposure to cereal grains, it has been shown that allergy to wheat is more frequent when wheat is introduced after 6 months of age into the children's diet [20]. This statement could explain the result in our study assuming that the Algerian diet involves eating wheat in different forms and dishes especially for the young aged kids. More than 62% suffered from digestive symptoms, then comes cutaneous and respiratory signs (25% and 12.5%, respectively). According to the literature, symptoms of IgE mediated wheat allergy may change with age [21].

According to our findings, the prevalence of milk allergy was 1.1%. The same result was found in cases follow up study. It showed that the prevalence of IgE-mediated cow's milk proteins allergy (CMPA) in Algeria was 1.1% [5]. In the same context, another study on 2015 revealed the prevalence of CMPA to be 3.64% in a pediatric population in Constantine, Algeria [4]. The allergy to milk is known to affect children at an early age [9], the median age of appearance of this allergy in our work was 1.2 years. This fluctuation could be explained by a late weaning in the Algerian society. Due to religious reasons [22], Algerian mothers tend to wean children around the age of 2 years old.

The prevalence of allergy to eggs was estimated at 1.1%. This food is also one of the most common foods causing allergy worldwide in children. The prevalence of eggs' allergy among kids varies from 0.3% to 9.9% according to several studies [10,15]. According to an investigation in a population-based cohort study, the prevalence of challenge-confirmed food allergy to eggs at age 1 and 4 years was 1.2% (95% CI, 0.9% to 1.6%) [23]. Those findings are comparable to ours, showing that the studied population is in accordance with the international data.

According to our work, strawberry appeared to be one of the most common foods causing allergy in schoolchildren with a prevalence of 1.1%. In the literature, allergy to this fruit is often reported but rarely confirmed. The work of Collins et al. reported one case study of 9-year-old boy with a history of strawberry and raspberry anaphylaxis in France [24]. Among schoolchildren (3–11 years old) from Central Portugal, a study reported that the most frequent food group causing food allergy was fresh fruits including strawberry as the top fruit in the list [25]. The presence of histamine releasers in strawberry can also explain the prevalence of the allergy of this fruit. In certain subjects the consumption of this fruit can cause non-specific histamine-releasing resulting allergic responses [26,27].

The study made by Lyons et al. reported the prevalence (95% CI) of food sensitization to fish in some European cities. The prevalence was 0.91% (0.40–1.42%) in Madrid (Spain) and 0.76% (0.44–1.08%) in Vilnius (Lithuania) [10]. These results are comparable to ours, where the prevalence of parent-reported food allergy to fish was estimated at 0.9%.

4.4. Food allergy symptoms

Among the clinical manifestations, the dermatologic signs affected 68.6% of the children, followed by digestive signs (19.6%) then respiratory symptoms (11.8%). Many studies confirm these findings. For instance, the main clinical manifestation in the IgE mediated adverse food reaction in Portuguese children was mucocutaneous [25]. In the same context, another investigation reported that food allergy related adverse reaction in children having immediate food allergy was mainly skin symptoms (62%) [28].

Anaphylaxis is the most severe presentation of food allergy; it can ultimately lead to death if not treated. As a systemic reaction, anaphylaxis may present with symptoms targeting different organs [29]. According to our results, 13% of the children had cutaneous and respiratory issues, cutaneous and digestive symptoms or respiratory and digestive symptoms at once. Even though, no anaphylactic reaction was reported by the parents, but the presence of combined symptoms in those children could be a characteristic of anaphylaxis.

4.5. Limitations of the study

This type of studies has certain limitations and bias that we are aware of; especially the subjectivity of the answers. One of the main biases that could interfere in the prevalence of food allergy is the absence of a question about the diagnostic of the allergy in the survey. For instance, the presence of pseudo-allergic reaction like the ones caused by foods containing histamine releasers (chocolate, strawberries) can cause an overestimation of some allergies. Furthermore, some "yes" answers could be confusing food allergy with other reactions. An additional bias in such studies could be due to avoidance of eating. Some people simply refuse the consumption of some foods because they say they don't like them. Actually, sometimes they are allergic and instinctively avoid the consumption even if they are not aware of allergy. It happens, for instance, in people with digestive problems due to allergy.

5. Conclusion

The results showed for the first time the prevalence of parent-reported food allergy among schoolchildren in the city of Guelma (Algeria). The prevalence of reported food allergy was estimated at 8.5% (95% CI 6.1–10.8). On contrary to gender, family history was found to be the main risk factor influencing the appearance of food allergy in children. Overall, the results provided by the survey were comparable with the data available in the literature.

In contrast, an outstanding prevalence of food allergy to chocolate (1.7%) was found. Additional investigations should be done in order to provide more precise data on this food allergy. Clinical demonstrations such as skin prick test, search of specific IgE or Placebo-Controlled Food Challenges (DBPCFCs) should be used to confirm this allergy.

Disclosure of interest

The authors declare that they have no competing interest.

Acknowledgement

We sincerely thank all the primary schools' directors and teachers for facilitating the run of the study in the schools in a short time and during the period of exams.

We are also grateful to the parents for taking time to answer the survey's questions and giving it back in time.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at <https://doi.org/10.1016/j.reval.2021.06.005>.

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