

# Prevalence of Food Allergy among Schoolchildren and its Association with the Coexistence and Severity of Asthma, Rhinitis, and Eczema in Damanhour City

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## Abstract

**Background:** Food Allergy (FA) is an issue of public health concern since it triggers life-threatening reactions. FA is an adverse immune reaction to a food allergen, mainly of protein nature. **Aim:** to assess the prevalence of food allergy with the coexistence and severity of asthma rhinitis and eczema in Damnhour city. **Subjects and Methods:** Schoolchildren aged 6–15 years (n 2140) were enrolled in a cross-sectional study. Parents and children completed questionnaires regarding their children's early life exposures and clinical history of FA and allergic diseases. Associations were assessed using Poisson regression with robust variance estimation, and adjusted prevalence ratios (aPRs) and 95% confidence intervals (CIs) were estimated. **Results:** The 12-month prevalence of study-defined FA was estimated to be 7.1% (150/2140), The mean age of the studied cases was  $10.47 \pm 2.42$  years, there was female predominance about 51.5%, fruits in 16.7%, cow's milk in 13.3%, egg in 11.3%, chocolate in 10.7%, were the most reported offending food allergens. Eosinophilia was  $2.57 \pm 1.2$ , the mean total IgE was  $129.21 \pm 47.5$ . The prevalence of eczema only was higher in children with study defined FA than in those without study-defined FA. In contrast, this association was not pronounced for children who had asthma only or rhinitis only. Moreover, study-defined FA was associated with increased severity of symptoms of asthma, rhinitis, and eczema.

**Conclusions:** FA affects a considerable proportion of schoolchildren in damanhour city, and the most reported offending food allergens are like those reported in Western countries.

**Keywords:** Food allergy; Prevalence; Asthma; Rhinitis; Eczema.

## Introduction

Food allergy is considered a serious public health and food safety concern. According to current epidemiological data, it is estimated that food allergy exists in up to 10% of the worldwide population, among which 8%-10% are school children <sup>(1)</sup>. Previous research reveals that 40% of children with food allergies report a severe life-threatening reaction in their lifetime, and one in five reports at least one food allergy related emergency department visit each year<sup>(2)</sup>.

The prevalence of IgE-mediated FA is highest in infancy and early childhood, driven by a relatively high prevalence of egg and cow's milk allergy that often resolves later in childhood. By contrast, peanut and tree nut allergies, which also typically present in infancy, are less likely to resolve and therefore predominate in later childhood <sup>(3)</sup>.

Food allergy rates vary by age, local diet, and many other factors <sup>(4)</sup>. More recent studies have shown that large differences in FA prevalence can exist even within individual countries, with some of this difference driven by a lower prevalence in rural areas compared with urban areas<sup>(3)</sup>.

Food allergic reactions can be classified into two main types: Immunoglobulin-E (IgE)-mediated reactions and non-IgE-mediated reactions. IgE-mediated reactions are type 1 hypersensitivity reactions where the symptoms are usually of quick onset occurring within few minutes up to a couple of hours of exposure to the culprit allergen. The symptoms include cutaneous, respiratory, gastrointestinal, cardiovascular symptoms or life-threatening anaphylaxis. Non-IgE-

mediated reactions tend to be more delayed with the onset more than 2 hours, often 2 days later, and tend to affect the skin and gastrointestinal systems<sup>(5)</sup>.

**Aim of the study:** to assess the prevalence of food allergy with the coexistence and severity of asthma rhinitis and eczema in Damnhour city.

## Methods

### Study setting, design, and participants

A descriptive cross-sectional study, all the children were subjected to a questionnaire which translated into Arabic; Clinical assessment, and Laboratory investigations.

The study was carried out in school children of Mohamed Khamis for primary Language school, Al-Zahra for primary languages and Secondary girls school, Boys Military High School in Damanhour in a time of the last academic year from its beginning to its end (**October 2021 to May 2022**). The study was conducted after obtaining the approval from the local ethics committee, Faculty of Medicine, Benha University {M.S.16.9.2020 }.

The sample of the study was chosen by systemic random method; the total number of primary and secondary school students at the previously mentioned settings was 10700 students. Students were placed in a list with a serial number, and then the starting point was randomly selected, and then every 5th of students were taken to be in the sample. Students were chosen were 2140 primary and secondary school students. Mohamed Khamis for primary

Language school 2820 , Al-Zahraa for primary languages and Secondary girls school 4460 , Boys Military High School 3420 The children were asked to take home the study-specific questionnaire and a standardized questionnaire (i.e., the International Study of Asthma and Allergies in Childhood (ISAAC) questionnaire<sup>(6)</sup> socio-demographic information, food allergy, clinical manifestations and other types of allergylike asthma, rhinitis and eczema for parental/guardian completion and return them to school. The questionnaires gathered information on the demographic data, lifestyle factors, environmental exposures, and clinical history and symptoms of FA, asthma, rhinitis, and eczema of the children.

*Food allergy:* We used previously published robust clinical diagnostic criteria<sup>(7)-(8)</sup> to determine FA status among study participants in the past 12 months (i.e., current FA status).

The applied prior definition of FA was based on convincing clinical history that encompassed the following criteria:

1. reporting at least one adverse reaction to a common food allergen, including cow's milk, egg, peanut, tree nut, fish, shellfish, soy, wheat, and sesame<sup>(9)</sup> ;
2. reporting at least one recognized allergic symptom, including the following<sup>(6)</sup> :
  - a. localized symptoms: itching, sting/burning of the lips/mouth or throat, urticaria/hives, angioedema.
  - b. abdominal symptoms: nausea, vomiting, crampy/colicky abdominal pain, diarrhea.
  - c. respiratory symptoms: wheeze, stridor, watery rhinitis, redness of eyes/nose.

d. skin symptoms: urticaria, itching, flushed skin, worsening eczema; e. systemic reactions: anaphylaxis, syncope; and

3. reporting a temporal relationship of a reaction, with symptoms occurring within 2 h of food ingestion<sup>(9)</sup>. Children were classified as having FA if they fulfilled criteria 1, 2, and 3. This approach allowed us to estimate the 12-month (current) prevalence of FA. In the remainder of the paper, we refer to this variable as “study-defined FA”<sup>(8)</sup>.

The questionnaire was translated into Arabic. Phrases that were difficult for children to understand were changed and if there was no suitable word for them a verbal explanation was added as part of the study guidelines.

Ascertainment of exposure and covariate variables

Information regarding exposures and covariates was obtained from questionnaires completed by the parents/guardians. Since body mass index (BMI), which is a measure of general adiposity, markedly changes in children with growth, we estimated the BMI-for-age z-scores (standard deviation [SD] scores) using the WHO growth reference for those aged between 5 and 19 years<sup>(11)</sup>. The BMI-for-age score was categorized as follows: underweight (thinness):  $<-2$  SD, normal:  $-2$  to  $1$  SD, overweight:  $>1$  to  $2$  SD, and obese:  $>2$  SD.<sup>(11)</sup>

Laboratory investigations:

1- CBC. 0.5 ml of EDTA whole blood sample by automated hematology  
2-Total IgE serum sample by electrochemiluminescence immunoassay (ECLIA)

### Statistical analysis

All data were collected, tabulated and statistically analyzed using (IBM SPSS Statistics for Windows, Version 23.0. Armonk, NY: IBM Corp.2015). Quantitative data were expressed as the mean  $\pm$  SD & median (range), and qualitative data were expressed as & (percentage). T test was used to compare between two groups, normally distributed variables. Percent of categorical variables were compared using Chi square test or Fisher Exact test when appropriate. Pearson' or spearman correlation coefficient was calculated to assess relationship between various study variables, (+) sign indicate direct correlation & (-) sign indicate inverse correlation, also values near to 1 indicate strong correlation & values near 0 indicate weak correlation. Logistic regression is a predictive analysis is used to describe data and to explain the relationship between one dependent categorical variable and one or more independent continues or categorical variables, Hosmer and Lame show test was used to detect goodness of fitness of logistic regression model . All tests were two sided. P-value < 0.05 was considered statistically significant (S), and p-value  $\geq$  0.05 was considered statistically insignificant.

### Results

This study was carried on 2140 patients, the mean age of the studied cases was

analyzer.

10.47 $\pm$ 2.42 years, there was female predominance about 51.5% .

The mean age of the studied cases was 10.47 $\pm$ 2.42 years, there was female predominance about 51.5%, the mean weight was 39.64 $\pm$ 5.57Kg, the mean height was 136.96 $\pm$ 31.41, the most common mode of birth was caesarean section in 69.1%, 55% of their mather were university education and higher, 55.8% of them had history of consanguinity, family historyof food allergy were present in 19.4%, The ventilation condition of the house were good in 78.2%, only 2% had history of exposure to dust and smoke, 6.0% of their fathers were smokers, 76.3% of them were breast feeders, and 54.3% were the first child Table (1).

In the current study, there were 7.1% of the studied cases had food allergy while in 92.9% had not food allergy Table (2).

Table 3 showed the common food allergens were fruits in 16.7%, vegetables in 14.7%, cows milk in 13.3%, egg in 11.3%, chocolate in 10.7%, fish in 8%, peanut in 5.3%

Table (4 showed that, 53.3% of the studied cases had Urticaria/hives, itching, or flushing as skin reaction. 13.3%, 9.3%, 6% respectively had abdominal pain and or distention, diarrhea and nausea and vomiting as a gastrointestinal reactions. There were 32% had wheezes and cough, 15.3% had sneezing and 13.3% had rhinorrhea/conjunctivitis as respiratory reactions

Table (5). The mean absolute eosinophilic count was  $129.21 \pm 47.5$  IU/L, the mean total IgE count was  $161.3 \pm 5.68$ .

**Table (1):** Socio-demographic characteristics among studied children.

N=2140	
<b>Age/years</b>	
- Min. – Max.	6.00-15.00
- Mean $\pm$ SD	10.47 $\pm$ 2.42
<b>Sex</b>	
Male	1037(48.5)
Female	1103(51.5)
<b>Weight(Kg)</b>	
Min. – Max.	18.60-82.00
Mean $\pm$ SD	39.64 $\pm$ 5.57
<b>Height(cm)</b>	
Min. – Max.	95-171
Mean $\pm$ SD	136.96 $\pm$ 31.41
<b>Body mass index (kg/m<sup>2</sup>)</b>	
Min. – Max.	15.6-21.17
Mean $\pm$ SD	17.53 $\pm$ 3.23
<b>Mode of Birth</b>	
Vaginal	660(30.8)
Cesarean section	1480(69.1)
<b>Mothers' education</b>	
Illiterate	10(0.5)
Primary education	51(2.4)
Secondary or technical education	903(42.2)
University education and higher	1176(55)
<b>Consanguinity</b>	
yes	945(44.2)
no	1195(55.8)
<b>Family history of allergy:</b>	
Yes	816(38.1)
No	1324(61.86)
<b>The ventilation condition of the house:</b>	
Good	1673(78.2)
Not good	467(21.8)
<b>Exposure to dust and smoke (pollution)</b>	
Yes	42(2)
No	2098(98)
<b>Smoking</b>	
Yes	1211(56.5)
No	929(43.5)
<b>Breastfeeding</b>	
Yes	1632(76.3)
No	508(23.7)
<b>Child order</b>	
First	1162(54.3)
Second	465(21.7)
Third or more	513(23.9)

**Table (2):** prevalence of food allergy among studied sample

food allergy	N=2140	%	
Absent	1990	92.9	
Present	150	7.1	
<b>Sex</b>	<b>53</b>	<b>35.33</b>	
<b>Male</b>		<b>53</b>	<b>35.33</b>
<b>Female</b>	<b>97</b>	<b>64.66</b>	<b>64.66</b>

**Table (3) :** common food allergens with the presence of food allergy symptoms among studied children.

	N=150	%
<b>Type of food</b>		
<b>Egg</b>	17	11.3
<b>Fish</b>	12	8
<b>Peanut</b>	8	5.3
<b>Chocolate</b>	16	10.7
<b>fruits (mango ,strawberry ,peach)</b>	25	16.7
<b>Vegetables</b>	45	14.7
<b>Cow's milk</b>	20	13.3
<b>Shell fish</b>	2	1.3

➤ **More than one food allergens could be present**

**Table (4):** Reactions to foods according to the affected organ system among children with study-defined food allergy

	N=150	%
<b>Skin reactions</b>	80	53.3
<b>Urticaria/hives, itching, or flushing swelling</b>	8	5.3
<b>Total</b>	88	58.7
<b>Gastrointestinal reactions:</b>		
<b>Itchy lips, mouth, or throat</b>	2	1.3
<b>Nausea/vomiting</b>	9	6
<b>Diarrhea</b>	14	9.3
<b>Abdominal pain and or distention</b>	20	13.3
<b>Lip swelling</b>	5	3.3
<b>Total</b>	50	33.33
<b>Respiratory reactions:</b>		
<b>Rhinorrhea/conjunctivitis</b>	20	13.3
<b>Wheeze and cough</b>	48	32
<b>Shortness of breath</b>	12	8
<b>Sneezing</b>	23	15.3
<b>Total</b>	103	68.7

More than one system could be affected

**Table (5):** Eosinophilia and total IgE among studied children.

N=150	
Eosinophilic count cells/microL:	
Mean± SD	161.35±5.68
Total IgE (IU/L)	
Min. – Max.	5.3-640.00
Mean ± SD	129.21±47.5
IgE:	
Normal	60(40%)
High	90(60%)

**Table (6):** Prevalence of allergic rhinitis, eczema and bronchial asthma among food allergy studied group.

	Food allergy		Test of significance	Odds ratio(95%CI)
	+ve	-ve		
	n=150(7.1%)	n=1990 (92.9%)		
<b>Allergic rhinitis</b>	98(65.33%)	922(46.33%)	$\chi^2=8.64$ <b>p=0.041*</b>	2.17(1.14-11.20) R
<b>Skin allergy</b>	62(41.3%)	1018(51.15%)	$\chi^2=0.146$ p=0.643	1.52(0.58-2.19) R
<b>Bronchial asthma</b>	75(50%)	1015(51%)	$\chi^2=0.135$ p=0.673	1.12(0.64-1.69) R

Table (6) showed there was a statistically significant relation in between presence of Food allergy and Allergic rhinitis . Table (7) showed the most common predictors of food allergy were young age, low

weight, +ve consanguinity, Family history of allergy, The ventilation condition of the house, Exposure to dust and smoke (pollution), smoking, Child order and Mode of Birth.

**Table (7):** predictors and risk factors of food allergy among studied group.

Predictors	$\beta$	P	AOR(95% CI)
Age/years	2.58	<0.001*	13.23(6.7-25.79)
Sex	1.160	0.304	1 3.19(0.35-29.18)
Weight(Kg)	0.87	0.001*	1 2.39(1.43-4.01)
Mothers' education			
Illiterate	.473	0.118	1.61(0.88-2.9)
Primary education			1
Secondary or technical education			
University education and higher			
Consanguinity	.848	0.004*	2.34(1.31-4.17)
Yes			1
No			
Family history of allergy:	0.79	0.04*	2.21(1.04-4.7)
Yes			
No			
The ventilation condition of the house:	0.834	0.01*	1.43(1.22-1.88)
Good			
Not good			
Exposure to dust and smoke (pollution)	2.220	<0.001*	1.10(1.03-1.37)
Yes			
No			
smoking	3.0	<0.001*	1.05(1.02-1.22)
Yes			
No			
Breastfeeding	1.359	0.063	1.25(0.06-1.98)
Yes			
No			
Child order	1.606	<.001*	4.98(2.92-8.49)
First			1
Second			
Third or more			
Mode of Birth	0.95	0.02*	2.59(1.11-6.06)
Vaginal			
Cesarean section			

AOR: Adjusted odds ratio CI: Confidence interval

## Discussion

Food allergy is a global health problem in developed as well as developing countries. Data on the epidemiology and pattern of FA from most developing countries are quite limited <sup>(12)</sup>. Regarding to BMI, the

mean BMI in our study was  $17.53 \pm 3.23$  which consistent with a survey in Korea and found the mean BMI at 2012 was  $18.00 \pm 3.20$  <sup>(16)</sup>. According to allergic rhinitis, was seen in 24.48% of the studied



cases while in another study was seen in 13.1% of their studied cases <sup>(4)</sup>. In our study, bronchial asthma was seen in 27.57% of the studied cases and in another study the prevalence of asthma in their studied cases was 46.1% <sup>(18)</sup>. Regarding skin allergy, it was seen in 50.5% of the studied cases and that was near to that mentioned in the study which found that atopic dermatitis in 33.5% of their studied cases <sup>(16)</sup>.

In the present study, 38.08% of the bronchial asthma patients had reaction to a special food and agreed with that childhood asthma is often associated with allergies. The incidence of allergic asthma varies and is highest in the age group of 0–9 years and lowest in the age group of 50–59 years <sup>(19)</sup>. Several studies have shown that children with asthma are more sensitive to food allergens than the general population, and this sensitization is associated with increased severity of asthma <sup>(20)</sup>. Children with food allergies are more often diagnosed with asthma reported a high prevalence of food allergies in inner-city school-age children with asthma. Additionally, the authors conclude that food allergies are associated with increased asthma morbidity and health resource utilization with decreased lung function, especially in children with multiple food allergies <sup>(20)</sup>.

In the present study, there were 7.1% of the studied cases had food allergy and that similar to the study done at Ain Shams University Hospitals found that 9.5% of their studied cases had food allergy <sup>(21)</sup>. The prevalence of self-reported food allergies was 8% among university students in the United Arab Emirates <sup>(22)</sup> and 12% among university students in Kuwait <sup>(23)</sup>.

The clinical data showed that the most common food allergens were: hen's egg (35%), peanut (24%), fish (4%) and cow's milk (8%) <sup>(24)</sup>. Regarding to sensitization to fruits, In the present study 16.7% had fruits sensitization which near to that found 20.5% of children sensitized to mango <sup>(25)</sup>.

In the present study, the mean total IgE was  $129.21 \pm 47.5$  IU/L, that near to a study that found the mean total IgE was  $194.90 \pm 328.00$  IU/L <sup>(16)</sup>. As regard to IgE, there were 60% of the food allergy cases had elevated IgE while in other study there were only 30.5% of the studied cases had elevated IgE <sup>(25)</sup>.

Among study defined food allergy, allergic rhinitis was the most common form of allergy in 65.33% followed by bronchial asthma in 50% eczema in 41.3% while in Zagazig university study urticaria was the most common form of allergy in adults (46; 56.7%) while asthma was the

most common form in children (14; 37.8%), patients from both groups were also presented by rhinitis, eczema and GIT symptoms <sup>(25)</sup>.

## Conclusion

1. Food allergies remain an important health concern due to increasing prevalence worldwide, fruits, vegetables, cow's milk, egg, chocolate, fish, peanut were the most prevalent frequent allergens that patients were sensitized to.
2. The prevalence of asthma and other atopic disease among Egyptian school children is high, prevalence of asthma, allergic rhinitis, and atopic dermatitis among school children in Damanhur city were 50.9%, 47.7% and 50.5%, respectively.

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