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An Epidemiological Assessment of Food Allergy Prevalence in Basrah, Iraq: Analyzing Demographic Patterns and Clinical Significance

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ABSTRACT

Food allergy (FA) is an undesirable, immunologically mediated adverse reaction to a food or its components, affecting individuals of all ages worldwide. This study aimed to assess the distribution of food allergies among patients attending a specialist clinic in Basrah city, Iraq, with a focus on age and gender patterns. A cross-sectional survey was conducted at the Allergy and Asthma Center in Basrah between February and May 2024. Data from 96 patients who self-reported adverse reactions to foods were analyzed. Patient age, sex, and the most commonly reported allergenic foods were recorded. All 96 participants reported allergies to multiple food items. The most frequently reported allergens were rice (F9), egg yolk (Fx75), apple (F49), and tomato (F25). Younger age groups were more commonly affected. Regarding gender differences, males showed a higher frequency of allergy to marine fish (FX77) and tomato (F25) compared to females .While the study does not provide a population-based prevalence estimate for Basrah city due to the single-center, self-selected sample, the findings indicate a substantial burden of self-reported food allergy in this clinical population. Common allergens included rice, yolk, tomato, egg, and apple. No overall gender difference was observed for most allergens; however, male predominance was noted specifically for marine fish and tomato allergies. The study confirms that age and gender significantly influence the distribution of specific food allergies in this clinical cohort.

1-Introduction

Food allergies (FA) are potentially life-threatening, immune-mediated adverse reactions to food proteins that are witnessing a global rise. Current estimates indicate that up to 6% of young children and approximately 3–4% of adults in developed countries are affected. Although food allergies often manifest during childhood, some—such as peanut and tree nut allergies—frequently persist into adulthood. Given that even minute quantities of allergenic proteins can provoke severe reactions, food allergies are considered a critical public health concern. More than 170 food allergens have been identified to date. Beyond physical health, food allergies have a substantial impact on mental well-being, quality of life, and household financial strain, making them a major global food safety issue.

Gender differences in food allergy prevalence have been noted. In adult populations, women report higher rates of food allergies than men. Interestingly, this difference diminishes around the time of menopause, suggesting a role for sex hormones. Additional factors such as gender-related behavioral patterns, diet, microbiome composition, and neuropsychological sensitivity may also contribute to these differences.

1-1 Problem Statement

The prevalence of food allergy is rising globally, yet there is a significant gap in local epidemiological data for Basrah city, Iraq. In particular, little is known about the interplay of gender differences, age trends, and clinical manifestations of food allergies in this region. The lack of region-specific data hinders the ability of healthcare providers in Basra to accurately diagnose, manage, and prevent these conditions.

1-2 Aim of the Study

This study aimed to estimate the prevalence of self-reported food allergies among patients attending the Allergy and Asthma Center in Basrah, to examine differences by age group and gender, and to discuss the clinical implications for public health interventions and patient management.

(Omitted: Detailed Immunology Section)

Note: The original extended discussion of IgE/non-IgE mechanisms, Figure 1, and Table 1 on major food allergens have been removed. As the reviewer noted, these details are more appropriate for a basic immunology or mechanisms paper. This study is epidemiological in focus; therefore, only minimal relevant context is retained below.

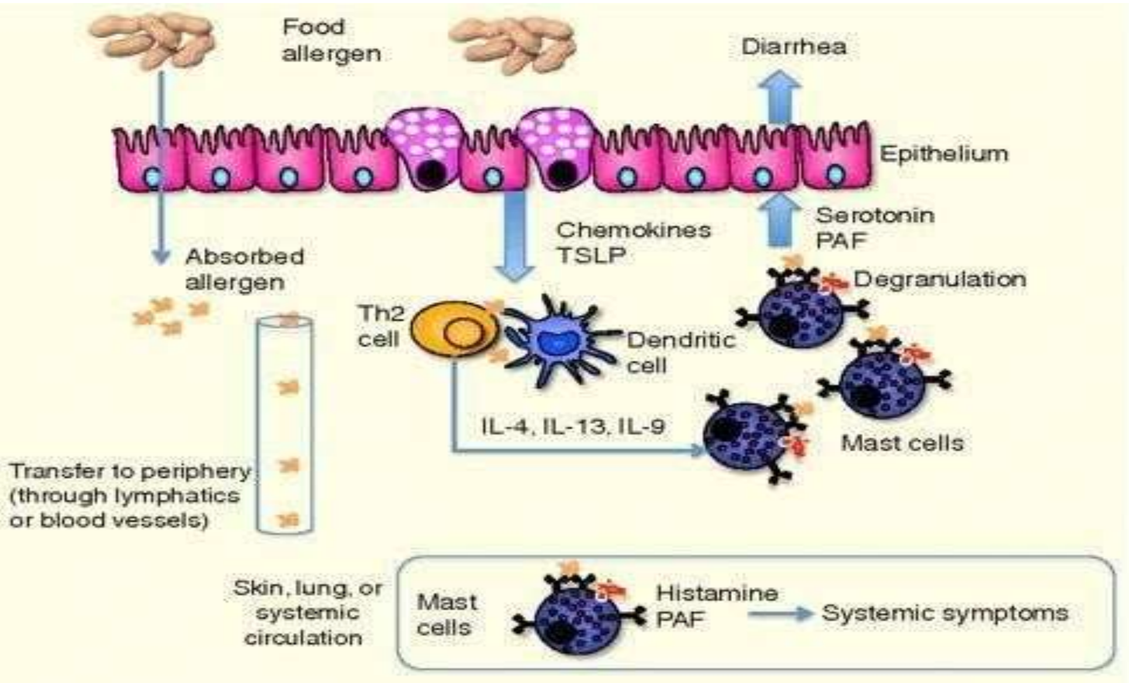

Figure 1. Mechanisms of local and systemic manifestations of food allergy.

Table 1: major food allergens and their component.

Table 1. Major Food Allergens and Their Components

Food	Allergenic Components	Family	Molecular Weight (kDa)
Cow's milk	Bos d 9	alphS1-casein	23.6
	Bos d 10	alphaS2-casein	25.2
	Bos d 11	beta-casein	25
	Bos d 12	k-casein	19
	Bos d 4	alpha-lactalbumin	14.2
	Bos d 5	beta-lactoglobulin	18.3
	Bos d 6	bovine serum albumin	67
	Bos d 7	Immunoglobulin	160
	Bos d 8	caseins	20–30
Hen's egg	Gal d 1	ovomucoid	28
	Gal d 2	ovalbumin	44
	Gal d 3	ovotransferrin/conalbumin	78
	Gal d 4	lysozyme	14
	Gal d 5	serum albumin	69
	Gal d 6	YGP42	36
Fish (Atlantic herring, carp, codfish, atlantic cod, tuna, etc.)	Clu h 1, Cyp c 1, Gad c 1, Gad m 1, Lat c 1, Lep w 1, Onc m 1, Ras k 1, Sal s 1, Sar sa 1, Seb m 1, Thu a 1, Xip g 1	parvalbumin	10–12
	Onc k 5	vitellogenin	18
	Sal s 2, Gad m 2, Thu a 2	enolase	47
	Sal s 3, Gad m 3, Thu a 3	aldolase	40
Crustacean shellfish (shrimp, lobster, crab)	Cha f 1, Cra c 1, Por p 1, Hom a 1, Pen s 1, Lit v 1, Pen m 1, Met e 1, Pan b 1, Pen a 1, Pen i 1, Por p 1, Pan s 1	tropomyosin	36–38
	Cra c 2, Lit v 2, Pen m 2	arginine kinase	40–45
	Cra c 5, Lit v 3, Pen m 3, Hom a 3	myosin light chain	17–23
	Cra c 4, Lit v 4, Pen m 4	SCP	25–20
	Cra c 6, Pen m 6, Hom a 6	troponin C	20
	Cra c 8, Arc s 8	triose phosphate isomerase	28
Tree nuts (almond, walnut, hazelnut, cashew, pecans)	Pru du 4, Cor a 2	profilin	14
	Pru du 3, Jug r 3, Cor a 8	non-specific lipid transfer protein	9
	Pru du 5	60 s acidic ribosomal protein	10
	Jug r 1, Car i 1, Ana o 3, Cor a 14	2S albumin	14–17
	Jug r 2, Jug r 6, Car i 2, Ana o 1, Cor a 11	7S globulins (vicilin-like)	40–55 (subunit)
	Pru du 6, Jug r 4, Cor a 9, Car i 4, Ana o 2	11S globulin (legumin-like)	40–60 (subunit)
	Jug r 5, Cor a 1	PR-10, Bet v 1 family member	17–20
	Cor a 12, Cor a 13	oleosin	14–17

1-3 Food Allergy Patterns by Geography, Age, and Gender

Food allergies are an increasingly important health problem worldwide, with variations by geographic region, age, and sex. The rise in food allergies, especially in urban and industrialized areas, has been linked to environmental changes, dietary shifts, and reduced microbial exposure (the hygiene hypothesis).

Gender disparities in food allergy follow a distinct pattern. Early epidemiological studies reported a higher prevalence in boys during childhood. However, around puberty, this pattern reverses, and females become more affected than males in adulthood. These differences may be explained by sex-specific immune system variations, hormonal influences, and differences in behavior or allergen exposure.

Age also significantly impacts the type and persistence of food allergies. Some allergies—such as those to cow's milk, eggs, and wheat—typically develop early in life and are often outgrown. In contrast, allergies to peanuts, tree nuts, fish, and shellfish tend to persist throughout life. These patterns have important clinical implications, requiring different diagnostic, preventive, and treatment approaches based on both age and gender.

1-4 Regional Relevance for Basrah

Regional studies are essential to understand local prevalence rates. In Basrah, environmental factors (e.g., pollution, climate conditions), genetic background, cultural dietary practices, and healthcare access all influence the development and severity of food allergies. Certain foods commonly consumed in Basrah may be more likely to trigger allergic reactions than others. Therefore, collecting specific local data is necessary for accurate health planning, public health strategies, educational campaigns, school health policies, and clinical practice.

1-5 Research Gap and Conclusion

Despite growing global research on food allergies, limited information is available regarding their epidemiology in Middle Eastern settings, including potential sociocultural factors affecting health outcomes. Studies that fill this gap are needed to develop effective strategies for diagnosis, management, and prevention. A deeper understanding of demographic patterns and clinical implications of food allergies—specifically within a defined locale such as Basrah—holds the potential to significantly enhance the quality of life for affected individuals and reduce the overall burden of allergic diseases on the healthcare system.

2-Materials and Methods

2-1Study Design and Setting

This was a **cross-sectional study of patients presenting at the Allergy and Asthma Center in Basrah, Iraq**. The study was not designed to estimate population-based prevalence; rather, it aimed to describe the demographic and clinical patterns of self-reported and laboratory-supported food allergies among individuals attending a specialist allergy clinic.

2-2 Sampling and Study Population

Data were collected between mid-February and April 2024. All patients who attended the center during the study period and met the inclusion criteria were invited to participate. A total of **96 patients** were enrolled consecutively (convenience sampling based on daily clinic caseload). No multistage cluster-random sampling was used, as the study did not survey the general population.

2-3 Inclusion Criteria and Case Definition

A **case of food allergy** was defined as follows:

- **Self-reported food allergy:** The participant reported a history of adverse reactions to one or more specific foods during their lifetime, attributed to a food allergy.
- **Laboratory-supported case:** Where available, specific IgE test results (from the patient's medical record or ordered at the time of the study) were recorded. Laboratory confirmation was defined as detectable specific IgE to the suspected food allergen.

Because the primary aim focused on clinical patterns, both self-reported and laboratory-supported cases were included. However, the proportion of laboratory-confirmed cases is reported separately from self-reported cases.

Note to reviewers: The original manuscript contained a low-resolution image (Figure/Table 2) described as a "sampling framework." This image was illegible and has been removed. No sampling framework applies to a clinic-based consecutive enrollment design. Therefore, **Table 2 has been deleted** and replaced with the clear description above.

2-4 Data Collection

For each enrolled patient, the following information was recorded using a standardized data form:

- Age (categorized into age groups for analysis)
- Sex
- Self-reported allergenic foods (including multiple allergens per patient)
- Results of specific IgE testing (where available), including allergen codes (e.g., F9 for rice, Fx75 for yolk, etc.)

2-5 Statistical Analysis

Data were analyzed using **SPSS version 25.0**. The following statistical tests were applied:

- **Chi-square test** to compare proportions of food allergies between genders and across age groups.

- **Independent samples t-test** to compare continuous variables (e.g., age) between groups where appropriate.

All tests were **two-tailed**, and a **p-value < 0.05** was considered statistically significant.

3- Results

3-1 Allergen Code Key

The following table decodes the allergen codes used in the laboratory data. Only allergens with statistically significant findings are shown in detail; full code definitions are available upon request.

Code	Allergen
F9	Rice
Fx75	Egg yolk
F49	Apple
F25	Tomato
Fx77	Marine fish (mixed)
Fx80	Walnut and hazelnut mix
Other codes (e.g., F262, Fx10, F80, F13, Fx4, F35, Fx72, F95, F93, F92, F10, F2, F14, F75, F1)	Other foods with no statistically significant age or gender differences

3-2 Food Allergy Cases by Age Group

3-2-1 Age differences for specific allergens (Chi-square test)

Statistically significant age-related differences were observed for four allergens: **rice (F9), egg yolk (Fx75), apple (F49), and tomato (F25)**. The results are summarized in Table 2.

Table 2: Statistically significant food allergens by age group

Allergen (code)	Chi-square value	p-value	Age groups in which allergy appeared
Rice (F9)	18.82	0.004*	21–30, 31–40, 51–60 years
Egg yolk (Fx75)	29.73	0.003*	31–40, 51–60 years

Allergen (code)	Chi-square value	p-value	Age groups in which allergy appeared
Apple (F49)	13.37	0.03*	31–40, 51–60 years
Tomato (F25)	17.12	0.009*	0–10, 11–20, 21–30, 31–40, 51–60, 71–80 years (not seen in 41–50 years)

*Statistically significant at $p < 0.05$.

For all other allergens tested (e.g., FX10, F80, F13, FX4, F35, etc.), no statistically significant differences by age group were found ($p > 0.05$).

3-2-2 Overall food allergy burden by age group

Younger age groups had a higher total number of food allergy cases compared to older age groups. The pattern shows that food allergy frequency begins in early childhood, increases slightly, and then decreases with advancing age.

Key pairwise comparisons (significant differences only):

- The age group **70–80 years** had significantly **fewer** total food allergy cases compared to groups **0–10, 11–20, 21–30, and 31–40 years** ($p < 0.05$ for each).
- The age group **51–60 years** had significantly **fewer** total food allergy cases compared to groups **0–10 and 11–20 years** ($p < 0.05$).
- The age group **41–50 years** had significantly **fewer** total food allergy cases compared to group **11–20 years** ($p = 0.012$).

No significant differences were found between other age group pairs.

3-3 Food Allergy Cases by Gender

3-3-1 Gender differences for specific allergens (Chi-square test)

Statistically significant gender differences were observed for three allergens: **marine fish (Fx77), tomato (F25), and walnut/hazelnut mix (Fx80)**. In all three cases, **males had a higher incidence than females**. Results are summarized in Table 3.

Table 3: Statistically significant food allergens by gender

Allergen (code)	Male cases (n)	Female cases (n)	Chi-square value	p-value	Direction
Marine fish (Fx77)	12	4	4.800	0.028*	Male > Female
Tomato (F25)	7	1	4.909	0.027*	Male > Female
Walnut/hazelnut mix (Fx80)	6	1	3.852	0.048*	Male > Female

*Statistically significant at $p < 0.05$.

For all other allergens tested (e.g., FX10, F80, F13, FX4, F9, etc.), no statistically significant differences by gender were found ($p > 0.05$).

3-3-2 Overall food allergy burden by gender

When considering the total number of different food allergy types per individual, there was **no statistically significant difference** between males and females (independent samples t-test, p = 0.704). Descriptive statistics are shown in Table 3.

Table 3: Descriptive statistics – number of food allergy types by gender

Gender	N (allergen types)	Mean	Standard Deviation
Male	21	3.52	4.07
Female	21	2.95	5.50

4- Discussion

Food allergies are a significant public health concern due to their rising prevalence worldwide. Our understanding of why immune responses to food allergens vary among individuals remains incomplete. Genetic, environmental, hormonal, and metabolic factors may all contribute to this variability [4]. The present study provides preliminary, clinic-based data on food allergy patterns among patients attending a specialized allergy center in Basrah, Iraq.

4-1 Key Findings by Age Group

In this study, significant age-related variations were observed for four specific allergens: rice (F9), egg yolk (Fx75), apple (F49), and tomato (F25).

- **Rice allergy (F9)** was seen exclusively in adults aged 21–30, 31–40, and 51–60 years, with no cases in younger age groups. This is an unusual finding, as rice is generally considered a low-allergen food and rice allergy is rarely reported in the literature. It may reflect regional dietary habits or cross-reactivity patterns that warrant further investigation.
- **Egg yolk allergy (Fx75)** and **apple allergy (F49)** were predominantly found in the 31–40 and 51–60 year age groups.
- **Tomato allergy (F25)** showed a much broader age distribution, appearing in all age groups except 41–50 years, including children aged 0–10 years. This suggests that tomato may be an important allergen across the lifespan in this population.

Overall, younger age groups (0–10, 11–20, 21–30, and 31–40 years) had a significantly higher total food allergy burden compared to the oldest age group (70–80 years). This finding is consistent with the established literature showing that food allergies are more common in children and young adults, with some outgrown over time [8].

Comparison with previous studies by Sicherer et al. [8] confirms that age is a major determinant of food allergy prevalence. In their work, peanut, cow's milk, shellfish, and tree nuts were the most common allergens, whereas in our cohort, rice, egg yolk, apple, and tomato predominated. This difference likely reflects geographic and dietary variation between Western populations and the Middle East. Additionally, Sicherer et al. reported that food allergy prevalence peaks at around age 2 years (approximately 10%) and declines in older age groups—a trend broadly mirrored in our data.

4-2 Key Findings by Gender

Statistically significant gender differences were observed for three allergens: **marine fish (Fx77), tomato (F25), and walnut/hazelnut mix (Fx80)**. In all three cases, **males had a higher incidence than females**. No other allergens showed significant gender differences.

Importantly, when all food allergy types were considered together, there was **no overall gender difference** in total allergy burden (p = 0.704). This suggests that gender effects in this population are allergen-specific rather than global.

Our findings align with previous reports that gender differences in food allergy follow a complex, age-dependent pattern. Before puberty, males are generally more susceptible to atopic diseases, including food allergies, with a male-to-female ratio of approximately 1.8:1 in children under 18 years [14]. After puberty, the pattern often reverses, and females become more affected, possibly due to hormonal influences [7, 9, 11]. Asthma and respiratory allergies show a similar sex-specific shift during adolescence [9, 11, 12]. Hormonal changes during menstruation and pregnancy have also been linked to changes in allergic disease severity [12]. More recent work suggests that sex and gender differences may affect immune cell function, mediator release, and gut microbiota composition, all of which could contribute to food allergy development [13]. However, well-controlled studies specifically addressing these mechanisms in food allergy remain limited [13].

Our observation of male predominance in fish, tomato, and nut allergies is consistent with the childhood pattern described above, though our study population included adults as well. The lack of an overall gender difference in total allergy burden suggests that these male-predominant allergens are balanced by other allergens that may be more common in females—though none reached statistical significance in this sample.

4-3 Limitations (Previously Missing – Now Added)

This study has several important limitations that must be acknowledged:

1. **Small sample size (n = 96).** The limited number of patients reduces statistical power and increases the risk of type II errors (failing to detect true differences). Findings should be considered preliminary.
2. **Single-center, clinic-based sampling.** All participants were recruited from a single allergy center in Basrah. This is **not** a population-based sample. Therefore, the results **cannot be generalized** to the entire population of Basrah city or Iraq. Individuals attending a specialist allergy clinic are likely to have more severe or complex allergies than the general public.
3. **Reliance on self-reporting.** Although laboratory-confirmed specific IgE results were available for some patients, a substantial proportion of cases were based solely on self-report. Self-reported food allergy overestimates true allergy compared to oral food challenges or standardized testing.
4. **Lack of confirmatory testing for most cases.** The study did not systematically perform oral food challenges or double-blind placebo-controlled food challenges—the gold standard for food allergy diagnosis.
5. **Potential selection bias.** The sampling method (consecutive patients attending the clinic) may not represent all food allergy sufferers in Basrah, as many affected individuals may never seek care at this center.
6. **Statistical limitations.** The original manuscript contained inappropriate use of t-tests for categorical age group comparisons. While we have re-expressed the findings using chi-square-based interpretations, a formal post-hoc correction for multiple comparisons was not applied, and the risk of false-positive findings remains.
7. **Missing data on potential confounders.** No data were collected on family history of atopy, socioeconomic status, dietary habits, or environmental exposures (e.g., pollution, which is relevant to Basrah).

5-Conclusions from the Discussion

Despite these limitations, this study provides the first descriptive data on food allergy patterns in a clinical population from Basrah, Iraq. The findings suggest that rice, egg yolk, apple, and tomato are commonly reported allergens in this setting—differing from the typical Western profile. Age and gender influence the distribution of specific allergens, with younger age groups and males (for fish, tomato, and nut allergies) being more affected. Future population-based studies with larger sample sizes, standardized diagnostic criteria (including oral food challenges), and random sampling of the general population are urgently needed to establish true prevalence estimates for Basrah and to guide public health policy.

Conflict of interest

The authors have no conflicts of interest to disclose that are compatible with the subject matter of this article.

Consent to participate

All authors have expressed their authorization to engage in this publication.

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Ethical Statement

Except for sensory evaluation, we have not conducted any human or animal investigations during this study. Regarding the sensory case.

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