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Is hen's egg a significant allergen in adults too? Findings from an investigation into food allergy prevalence

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Abstract

Introduction: Data on adult food allergies (FAs) remain limited compared to the pediatric population, and this study investigates the prevalence and clinical characteristics of FAs among adults.

Methods: This retrospective study included adults aged 18-80 diagnosed with FAs at the Immunology and Allergy Diseases Clinic of Ankara Bilkent City Hospital, Turkey, between 2019 and 2024.

Results: During the study period, 10,505 patients were examined to diagnose and manage various allergic and immunologic conditions. Among these, 563 patients were suspected of having FAs, which was confirmed in 33 patients (mean age 34.74 ± 12.57 years; 60.6% female), yielding a frequency of 0.31%. The primary allergens identified included hen's egg ($n = 6$, 18.2%), fish and shellfish ($n = 4$, 12.1%), and various nuts such as peanuts ($n = 2$, 6.1%), hazelnut ($n = 1$, 3.0%), and almond ($n = 1$, 3.0%) as well as seeds like sesame ($n = 2$, 6.1%) and sweet corn ($n = 2$, 6.1%) and fruits such as banana ($n = 4$, 12.1%) and kiwi ($n = 4$, 12.1%). The median time interval between food consumption and allergic reactions was 10 minutes (2-120). Anaphylaxis was the most frequently observed clinical presentation ($n = 24$, 72.7%). Emergency treatments included antihistamines and steroids ($n = 15$, 65.2%), antihistamines, steroids, and epinephrine ($n = 5$, 21.7%), or epinephrine alone ($n = 3$, 13.0%). Egg allergy was the most prevalent allergen ($n = 6$, 18.2%), characterized by a rapid onset of allergic reactions (median of 5 minutes); two patients reacted regardless of cooking methods and four showed tolerance to thoroughly cooked eggs, with component-resolved diagnostics indicating sensitization to ovalbumin (Gal d2) but not ovomucoid (Gal d1).

Conclusion: Our study demonstrates a low frequency of FAs in adults yet highlights the seriousness of reactions like anaphylaxis. Hen's egg allergy was notably prevalent, underscoring the need for increased awareness and improved diagnostic strategies to effectively manage FAs in the adult population.

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Introduction

The prevalence of food allergy (FA) is on the rise globally across all age groups, including adults. However, data regarding adult FAs remain significantly limited in comparison to pediatric counterparts. The prevalence of adult FAs varies depending on several factors, including geographical variation, food culture, age groups, and especially the definitions and diagnostic criteria employed in various studies.¹ A recent population-based study conducted in the United States reported a self-reported immunoglobulin E (IgE)-mediated FA prevalence of 10.8% among adults utilizing a well-structured survey.² Concurrently, a community-based survey across Europe revealed that the prevalence of adult FA ranges from 2% to 37%, reflecting considerable geographical variability.³ In Asia, there is a notable paucity of information regarding the prevalence of FAs among adults. A cross-sectional community-based study in Taiwan estimated the prevalence of FAs at 6.4%.⁴ In contrast to the higher prevalence observed through self-reporting, laboratory tests and oral food challenge (OFC) tests have demonstrated that the actual prevalence of FAs diagnosed is lower, ranging from 0.1% to 10%.⁵⁻⁷

There is also a significant gap in the literature concerning the characteristics and natural history associated with FA onset in adulthood. One particular study identified 171 cases of adult-onset FAs, finding that the age of onset generally peaks in the early 30s, with nearly 49% of these patients having experienced at least one episode of anaphylaxis.⁸ Among the newly identified food allergens, shellfish, tree nuts, fish, soy, and peanuts are reported to be the most prevalent.⁶ Furthermore, recent population-based studies suggest that classic childhood FAs can persist into adulthood, with more than 20% of commonly recognized allergens in childhood reported by adults.^{2,9}

Given this context, our study established the true frequency of FAs among adults at the Immunology and Allergy Diseases Clinic of Ankara Bilkent City Hospital, a tertiary care facility. Additionally, we investigated the demographic and clinical characteristics of patients with FAs and identified the specific allergens responsible for these allergies in the adult population. Our secondary objectives include examining the characteristics of the reactions triggered by these food allergens and gathering information regarding the treatment processes and management strategies employed for these patients.

Materials and Methods

Study design and study population

This study was designed as a retrospective analysis. We included all patients aged 18-80 years of both sexes who received a diagnosis of FA at the Immunology and Allergy Diseases Clinic of Ankara Bilkent City Hospital between 2019 and 2024. Patient records for those diagnosed with FAs were reviewed retrospectively to gather relevant clinical and sociodemographic information. This retrospective study was approved by the relevant ethics committee (Approval no: TABED 2-24-445), ensuring that patient confidentiality was maintained throughout the data collection and analysis process.

A structured data extraction form was utilized to systematically collect pertinent data from patient files, which included demographic characteristics such as age, gender, and educational status as well as a detailed history of allergic and systemic comorbidities. The clinical features of FA history were thoroughly documented, encompassing specific food items associated with allergic reactions and the time interval between food consumption and the onset of allergic symptoms. Additionally, the types of symptoms experienced were classified, including dermatological symptoms like urticaria, instances of oral allergy syndrome, and cases of anaphylaxis. Information on whether patients sought emergency care after experiencing an allergic reaction was also collected, along with details on the treatment administered in the emergency department and the duration of the response to such treatment. Regarding diagnostic tests, food-specific IgE (sIgE) levels, skin prick test (SPT) results specific to food allergens, and OFC results, if applicable, were documented. Furthermore, inhalant allergy assessments were conducted when relevant, along with results from inhalant-sIgE tests and SPTs. Total IgE levels and baseline serum tryptase levels, when available, were also included in the data collection process.

Diagnosis of food allergy

The diagnosis of FAs was established based on a combination of clinical history, symptomatology, and diagnostic testing¹⁰:

- **Clinical History:** A detailed account of the patient's symptoms occurring shortly after consumption of suspected allergenic foods was gathered, including specific food item(s), timing of symptom onset, and severity of the reaction.
- **Diagnostic Testing:** Sensitization in adult patients was evaluated through both in vivo testing using SPTs and in vitro testing measuring sIgE levels. The sIgE levels were determined using the Immulite 2000 system (Siemens Healthcare Diagnostics, Tarrytown, NY) for samples collected thereafter. Values of sIgE \geq 0.35 kU/L were considered positive for sensitization. SPT was conducted for at least 4-6 weeks following an anaphylactic reaction. Antihistamines were discontinued 1 week prior to testing to reduce potential interference with the results. The SPT was performed using commercially available allergen extracts (ALK, Abello, Madrid, Spain and Lofarma, Milano, Italy) as well as fresh food samples, including fruits, vegetables, and fish, utilizing the prick-to-prick method in accordance with the guidelines of the European Academy of Allergy and Clinical Immunology (EAACI). SPT was performed on the volar surface of the forearm. After a 15-minute interval, reactions were recorded, with a mean wheal diameter (the mean of the longest diameter and orthogonal diameter) of \geq 3 mm greater than that of the negative control deemed a positive outcome.

In cases where it could not be supported by sIgE testing and SPTs and the diagnosis remained uncertain,

supervised OFCs were conducted to validate with confidence any suspected FAs. The OFC was carried out in a controlled clinical environment under the supervision of healthcare professionals trained in the management of allergic reactions. Patients were instructed to avoid any allergenic foods for a minimum of 12 hours prior to the challenge. During the challenge, small, incremental doses of the suspected allergenic food were administered at regular intervals, with close observation between doses. The initial dose consisted of a small quantity of the food item, with amounts gradually increased based on the patient's tolerance. Patients were monitored for any adverse reactions throughout the process and symptoms were documented immediately after each dose. A positive result from the OFC was defined as the development of reproducible symptoms suggestive of an allergic reaction.¹⁰

Diagnosis of anaphylaxis

The diagnosis of anaphylaxis in this study was established based on the criteria set forth by two prominent guidelines: the "Anaphylaxis: Guidelines from the European Academy of Allergy and Clinical Immunology"¹¹ prior to end of the 2020 and the "World Allergy Organization Anaphylaxis Guidance 2020"¹² thereafter.

Statistical analysis

Statistical analyses were conducted using SPSS version 21 software (SPSS Inc., Chicago, IL, USA). Descriptive statistics for nominal data were presented as counts and percentages, while quantitative data were reported as means \pm standard deviations or medians along with minimum (min) and maximum (max) values, based on the distribution normality. Normality was assessed using the Kolmogorov-Smirnov or Shapiro-Wilk tests.

Results

Between 2019 and 2024, a total of 10,505 patients presented to our clinic, of which 563 were referred with suspected FA. Among those, FA was confirmed in 33 patients through SPTs, sIgE results, and OFCs with a consistent history of FA, resulting in an actual prevalence of FAs of 0.31% (Figure 1). The mean age of these 33 patients was 34.74 ± 12.57 years, with a predominance of females ($n = 29$, 60.6%). In terms of allergic comorbidity, the most common conditions were allergic rhinitis, observed in nine patients (27.3%), followed by asthma in four patients (12.1%). Additionally, inhaled allergen sensitization was noted in several patients, with pollen sensitization in eight patients (24.2%), house dust mite in four patients (12.1%), and a lesser prevalence of sensitization to cat (one patient, 3.0%) and latex (one patient, 3.0%) (Table 1).

The causative foods identified in these patients included hen's egg ($n = 6$, 18.2%), fish and shellfish ($n = 4$, 12.1%), and various nuts such as peanuts ($n = 2$, 6.1%), hazelnut ($n = 1$, 3.0%), and almond ($n = 1$, 3.0%) as well as seeds like sesame ($n = 2$, 6.1%) and sweet corn ($n = 2$, 6.1%) and fruits such as banana ($n = 4$, 12.1%), kiwi ($n = 4$, 12.1%), and lesser occurrences of avocado ($n = 1$, 3.0%), peach ($n = 1$, 3.0%), strawberry ($n = 1$, 3.0%), fig ($n = 1$, 3.0%), and coconut ($n = 1$, 3.0%). Other identified allergens included cow's milk ($n = 2$, 6.1%), mutton ($n = 1$, 3.0%), leek ($n = 1$, 3.0%), and garlic ($n = 1$, 3.0%). In this cohort, patients exhibited a median number of allergic reactions of 2, with a range from 1 to 20 episodes. Notably, 27 patients (81.8%) required admission to the emergency department due to the severity of their reactions. Among these, 24 patients (72.7%) were diagnosed with anaphylaxis as their most recent allergic manifestation, while 3 patients (9.1%) presented with generalized urticaria. Furthermore, an isolated angioedema was reported in two patients (6.1%), with an additional patient experiencing isolated generalized pruritus (3.0%) and yet another presenting with isolated gastrointestinal symptoms characterized by cramp-like

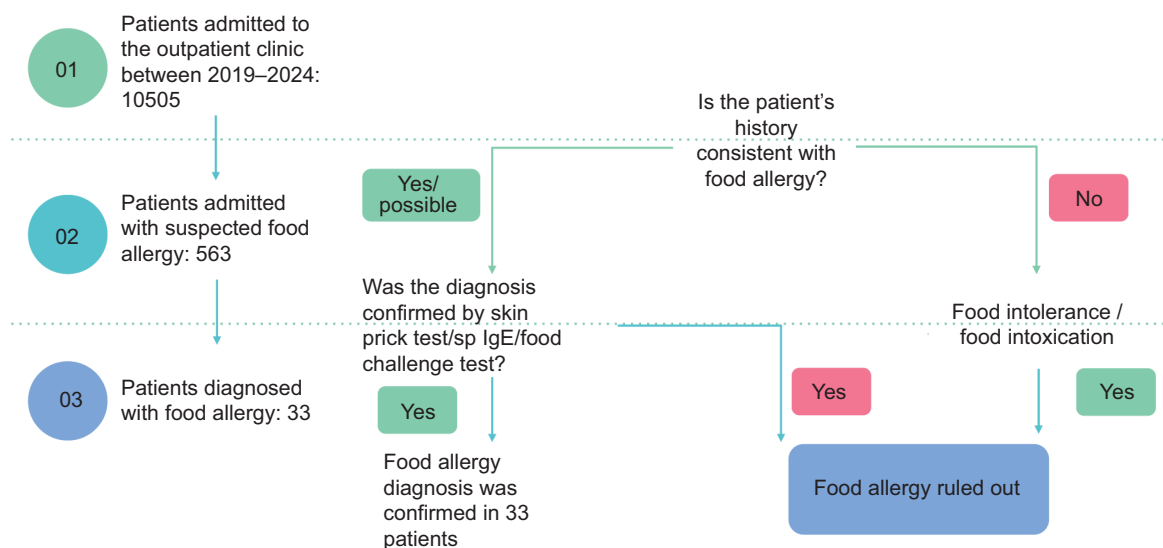


Figure 1 Flow chart of the study.

Table 1 Demographic and basic clinical characteristics of the patients (n = 33).

Age (mean ± SD)	34.74 ± 12.57
Sex (n, %)	
Female	20 (60.6)
Male	13 (39.4)
Allergic comorbidity (n, %)	
Allergic rhinitis	9 (27.3)
Asthma	4 (12.1)
Chronic urticaria	3 (9.1)
Venom allergy	2 (6.1)
Drug allergy	1 (3.0)
Allergic contact dermatitis	1 (3.0)
Presence of systemic comorbidity (n, %)	5 (15.2)
Inhaled allergen sensitization (n, %)	
Pollen	8 (24.2)
House dust mite	4 (12.1)
Cat	1 (3.0)
Latex	1 (3.0)

abdominal pain (3.0%). Oral allergy syndrome was observed in one patient (3.0%). The median time interval between food consumption and the onset of allergic reactions was determined to be 10 minutes, encompassing a range from 2 to 120 minutes, thereby underscoring the rapid onset of these potentially life-threatening responses. The analysis of organ and system involvement in the 24 patients (72.7%) who experienced anaphylaxis as their most recent allergic reaction revealed that 18 patients (78.3%) presented with urticaria and 19 (82.8%) exhibited angioedema. Additional five patients (21.7%) showed signs of rhinoconjunctivitis, marked by symptoms such as runny nose, nasal itching, and nasal congestion. Lower respiratory system involvement was significant, as 17 patients (73.9%) reported symptoms, including shortness of breath, wheezing, and cough. Gastrointestinal symptoms, notably nausea, vomiting, and abdominal pain, were observed in five patients (21.7%). Cardiovascular involvement was noted in 12 patients (56.5%) with manifestations, including tachycardia and hypotension. Last, two patients (8.7%) experienced syncope during their anaphylactic episodes. In terms of treatment administered in the emergency department, 15 patients (65.2%) received a combination of antihistamines and steroids. Five patients (21.7%) were treated with antihistamines, steroids, and epinephrine, while three (13.0%) received epinephrine alone (Table 2). There were no statistically significant differences in terms of age, gender, or the presence of allergic comorbidities between patients who experienced anaphylaxis and those who exhibited other forms of allergic reactions, indicating comparable profiles regarding the severity of allergic responses ($p > 0.05$ for each).

The diagnostic evaluation of patients presenting to our clinic revealed significant findings in allergen sensitivity testing. Skin prick tests yielded positive results in 17 patients (51.5%), with a median reaction size of 6.5 mm (min to max: 4-14.5). The sIgE testing demonstrated a high prevalence of sensitization as 23 patients (69.6%) showed positive results, with median sIgE levels measuring 1.96 kU/L (min to max: 0.338-100). Additionally, five patients

(15.2%) were diagnosed with a positive OFC, confirming their FAs through controlled exposure. The data also indicated that six patients (18.2%) exhibited component resolved diagnostics (CRDs), suggesting a refined understanding of their allergic profiles. Overall, the median total IgE level was reported as 120 kU/L (ranging from 9.40 to 421 kU/L) and the mean baseline tryptase level was measured at 5.75 ± 2.32 $\mu\text{g/L}$. It is important to note that the tryptase levels related to anaphylaxis were not available as these patients presented to the emergency department at external centers. The baseline tryptase levels reported were obtained during the diagnostic period when the patients came to our clinic. The summarized results of the patients are presented in Table 2, while the detailed individual data for each patient are in Table 3.

CRD, Component resolved diagnosis

Patient 29, a 24-year-old male, was diagnosed with milk allergy at the age of 4. However, a year earlier, in an attempt to determine himself whether the milk allergy persisted, the patient consumed milk and subsequently presented to the emergency department within 3 minutes with widespread urticaria and lip angioedema. Upon examination, the patient was found to have uvula edema, leading to a diagnosis of anaphylaxis. Treatment included intramuscular epinephrine, intravenous antihistamines, and 40 mg of methylprednisolone. The initial diagnosis in childhood was confirmed through OFC. Current testing revealed elevated levels of sIgE for milk (> 100 kU/L), alpha-lactalbumin (>100 kU/L), beta-lactoglobulin (>100 kU/L), and casein (>100 kU/L). As a result, milk and all dairy products were removed from the patient's diet, and an epinephrine autoinjector was prescribed along with instructions for its use (Table 3).

Egg allergy, the most prevalent food allergen in our study, was identified in six patients (18.2%). The age of onset for egg allergy ranged from 17 to 35 years. Our findings indicated a notably short time interval between egg consumption and allergic reactions, ranging from a mere 1 minute to 30 minutes, with a median of just 5 minutes. There was a correlation between cooking methods and symptom presentation in egg allergy. Two patients (Patients 4 and 6) experienced allergic reactions regardless of the extent or method of cooking. However, the remaining four patients (Patients 1, 2, 3, and 5) demonstrated tolerance for thoroughly cooked eggs, including fully boiled or baked egg products. The CRDs test revealed that these four patients, who tolerated well-cooked eggs, exhibited a positive response to ovalbumin but a negative response to ovomucoid. Since these patients exhibited sensitization specifically to ovalbumin and tolerated well-cooked and baked egg products, we concluded that the avoidance of thoroughly cooked eggs was unnecessary. They reported no further allergic reactions after adhering to the exclusion of undercooked egg products (Table 4).

All patients, excluding the one with oral allergy syndrome, were prescribed epinephrine autoinjectors. Dietary elimination of the triggering food was recommended for all patients. Food desensitization was not implemented for any patients.

Table 2 Clinical characteristics and confirmatory tests for the patients presenting with allergic reactions to different foods (n = 33).

Age of onset (year) (mean \pm SD)	32.03 \pm 13.42			
Causative food (n, %)	Hen's egg	6 (18.2)		
	Fish and shellfish	4 (12.1)		
	Nuts	Peanut	2 (6.1)	
		Hazelnut	1 (3.0)	
		Almond	1 (3.0)	
	Seeds	Sesame	2 (6.1)	
		Sweet corn	2 (6.1)	
		Fruits	Banana	4 (12.1)
	Kiwi		4 (12.1)	
	Avocado		1 (3.0)	
	Peach		1 (3.0)	
	Strawberry		1 (3.0)	
	Fig		1 (3.0)	
	Coconut		1 (3.0)	
	Cow's milk	2 (6.1)		
Mutton	1 (3.0)			
Leek	1 (3.0)			
Garlic	1 (3.0)			
Time interval between food consumption and reaction (min) (median, min to max)	10 (2-120)			
Time interval (n, %)	\leq 5 min	13 (39.4)		
	5-30 min	16 (48.5)		
	30 min	4 (12.1)		
Allergic reaction number (median, min to max)	2 (1-20)			
Last allergic reaction (n, %)	Anaphylaxis	24 (72.7)		
	Generalized urticaria	3 (9.1)		
	Isolated angioedema, excluding upper respiratory tract	2 (6.1)		
	Urticaria and angioedema	1 (3.0)		
	Isolated generalized pruritus	1 (3.0)		
	Isolated GIS (cramp-like abdominal pain)	1 (3.0)		
	Oral allergy syndrome	1 (3.0)		
	Patients admitted to the emergency department (n, %)	Among all patients	27 (81.8)	
Among patients with anaphylaxis		24 (100)		
Organ/system involvement (for patients with anaphylaxis history) (n, %)	Urticaria	18 (78.3)		
	Angioedema	19 (82.8)		
	Rhinoconjunctivitis (runny nose/nasal itching/nasal congestion/sneezing/red and itchy eyes)	5 (21.7)		
	Lower respiratory system (shortness of breath/wheezing/cough)	17 (73.9)		
	Gastrointestinal system (nausea-vomiting/abdominal pain)	5 (21.7)		
	Cardiovascular system (tachycardia/hypotension)	12 (56.5)		
	Syncope	2 (8.7)		
	Treatment administered in the emergency department for anaphylaxis (n, %)	Antihistamines and steroids	15 (65.2)	
Antihistamines and steroids and epinephrine		5 (21.7)		
Epinephrine		3 (13.0)		
Skin prick test positivity (n, %)		17 (51.5)		
Skin prick test (mm) (median, min to max)		6.5 (4-21)		
Specific IgE positivity (n, %)		27 (81.8)		
Specific IgE (kU/L) (median, min to max)		1.96 (0.56-100)		
Patients diagnosed with a positive food challenge test (n, %)		5 (15.2)		
Presence of component resolved diagnostics (n, %)		6 (18.2)		
Total IgE (kU/L) (median, min to max)		120 (9.40-421)		
Basal tryptase (μ g/L) (mean \pm SD)		5.75 \pm 2.32		

Table 3 Individual characteristics of food allergy patients.

Patient no	Age/sex	Age of food allergy onset	Causative food	Inhalen allergen sensitivity	Number of allergic reaction	Time interval between food consumption and allergic reaction (min)	Type of allergic reaction	Diagnostic test
1	30/F	28	Hen's egg	Absent	15	5	Anaphylaxis (last reaction)	Egg white Sp IgE: > 100 kU/L egg yolk Sp IgE: 74.6 kU/L CRD (ovalbumin: 91.5; ovomucoid: negative)
2	19/M	17	Hen's egg	Absent	15-20	15	Generalized urticaria	Egg white Sp IgE: 0.662 kU/L Egg yolk Sp IgE: 0.317 kU/L CRD (ovoalbumin: 0.630; ovomucoid: negative)
3	23/F	22	Hen's egg	Pollen	4-5	1-2	Anaphylaxis (last two reaction)	Egg white Sp IgE: 8.4 kU/L Egg yolk Sp IgE: < 0.10 kU/L CRD (ovoalbumin: 0.842; ovomucoid: negative)
4	40/F	30	Hen's egg	Pollen	10	3-4	Anaphylaxis (last reaction)	Egg white Sp IgE: 26.6 kU/L Egg yolk Sp IgE: 15.0 kU/L
5	35/M	34	Hen's egg	Pollen and house dust mite	2	30	Anaphylaxis	Egg white Sp IgE: 10.6 kU/L Egg yolk Sp IgE: 6.59 kU/L CRD (ovalbumin: 7.95; ovomucoid: negative)
6	35/F	35	Hen's egg	Absent	Missing data	5	Anaphylaxis	Skin prick test: 4 x 4 mm
7	61/F	60	Fish	Absent	2	15	Urticaria and angioedema	Egg white Sp IgE: 1.36 kU/L Egg yolk Sp IgE: 11.4 kU/L Skin prick test: 5 x 5 mm
8	47/F	43	Fish	Absent	1	10	Anaphylaxis	Skin prick test: negative Food provocation test: positive Sp IgE: 26.0 kU/L
9	36/F	34	Shrimp	Absent	1	2	Anaphylaxis	Shrimp Sp IgE: 2.34 kU/L
10	28/M	28	Shrimp	Absent	3	5	Generalized urticaria	CRD (Pen m1: 3.5)
11	31/F	31	Peanut	Absent	2	10	Anaphylaxis (last reaction)	Skin prick test: 7 x 5 mm
12	58/M	57	Peanut	Pollen	10	5	Anaphylaxis (last reaction)	Sp IgE: 1.69 kU/L Food provocation test: positive
13	19/F	17	Hazelnut	Pollen and house dust mite	1	1	Anaphylaxis	Skin prick test: 4 x 4 Sp IgE: 2.05 kU/L
14	42/M	41	Almond	Absent	2	60	Anaphylaxis	Skin prick test: 7 x 7 mm Sp IgE: 0.452 kU/L
15	40/M	38	Sesame	Absent	2	15	Anaphylaxis	Skin prick test: 7 x 4 mm

16	60/F	50	Sesame	Absent	1	5	Anaphylaxis	Skin prick test: 7 x 6 mm
17	27/F	27	Sweet corn	Absent	2	30	Anaphylaxis	Skin prick test: 7 x 7 mm Sp IgE: 0.758 KU/L
18	46/F	43	Sweet corn	Absent	3	15	Anaphylaxis (last two reaction)	Skin prick test: 4 x 4 mm Sp IgE: 0.338 KU/L
19	27/M	26	Banana, kiwi, avocado	Pollen and house dust mite	3	60	Isolated angioedema (eyelids and lips)	Banana Sp IgE: 1.54 KU/L Kiwi Sp IgE: 1.66 KU/L
20	20/M	19	Banana, kiwi	Latex	4	120	Anaphylaxis	Avocado Sp IgE: 0.422 Banana Sp IgE: 5.21 KU/L Kiwi Sp IgE: 9.53 KU/L
21	26/F	25	Banana	Absent	2	60	Isolated angioedema (eyelids and lips)	Banana Sp IgE: 1.01 KU/L
22	24/M	24	Banana	House dust mite	5	5	Anaphylaxis (last reaction)	Skin prick test: 5 x 4 mm Banana Sp IgE: 1.96 KU/L
23	55/F	54	Kiwi	Absent	1	2	Anaphylaxis	Skin prick test: 10 x 5 mm
24	27/F	27	Kiwi	Pollen and cat	2	5	Oral allergy syndrome	Kiwi Sp IgE: 0.36 KU/L
25	18/F	16	Peach	Pollen	9-10	2	Generalized urticaria	Peach Sp IgE: 1.45 KU/L
26	23/M	22	Strawberry	Absent	1	10	Anaphylaxis	Skin prick test: 4 x 4 mm Strawberry Sp IgE: 0.56 KU/L
27	28/M	24	Fig	Pollen	2	5	Anaphylaxis (last reaction)	Skin prick test: 23 x 6 mm
28	18/F	18	Coconut	Absent	>10	5	Isolated generalized pruritus	Food provocation test: positive Skin prick test: 4 x 4 mm Food provocation test: positive
29	24/M	4	Cow's milk	Absent	>5	3	Anaphylaxis (last reaction)	Cow's milk Sp IgE > 100 KU/L CRD (alpha lactalbumin > 100; beta lactoglobulin > 100; casein > 100) Food provocation test: positive (childhood)
30	19/F	17	Cow's milk	Absent	5-10	10	Isolated GIS (cramp-like abdominal pain)	Cow's milk Sp IgE: 3.40 KU/l
31	52/F	47	Mutton	Absent	6	10	Anaphylaxis	Mutton Sp IgE: 1.29 KU/l
32	36/F	33	Leek	Absent	2	120	Anaphylaxis	Skin prick test: 5 x 5 mm
33	43/M	42	Garlic	Absent	1	30	Anaphylaxis	Skin prick test: 6 x 5 mm Garlic Sp IgE: 0.470 KU/l

Table 4 Details of the characteristics of patients allergic to Hen's egg.

Age/ Sex	Profession	AC	Atopy	Age of onset	Time interval between food consumption and reaction (min)	The relation of the time and temperature of the cooking with the allergic reaction	Last allergic reaction	SPT (mm)	Total IgE kU/L)	Specific IgE (kU/L)	Component based testing	PT
30/F	Public official	Venom allergy	-	28	5	Related	Anaphylaxis	-	45	Egg white: > 100 Egg yolk: 74.6	Ovalbumin: 91.5 Ovomucoid: negative	-
19/M	Student	-	-	17	15	Related	Generalized urticaria	-	371	Egg white: 0.662 Egg yolk: 0.317	Ovalbumin: 0.630 Ovomucoid: negative	-
23/F	Student	AR, asthma	Pollen	22	1-2	Related	Anaphylaxis	-	102	Egg white: 8.4 Egg yolk: < 0.10	Ovalbumin: 0.842 Ovomucoid: negative	-
40/F	Housewife	AR, asthma	Pollen	30	3-4	Unrelated	Anaphylaxis	-	33.70	Egg white: 26.6 Egg yolk: 15.0	Ovalbumin: 7.95 Ovomucoid: negative	-
35/M	Public official	-	-	34	30	Related	Anaphylaxis	-	272	Egg white: 10.6 Egg yolk: 6.59	Ovalbumin: 7.95 Ovomucoid: negative	-
35/F	Public official	AR, asthma	Pollen and house dust mite	35	5	Unrelated	Anaphylaxis	4 x 4	360	Egg white: 1.36 Egg yolk: 11.4	-	-

AC: Allergic comorbidity; AR: Allergic rhinitis; SPT: Skin prick test; PT: Provocation test.

Discussion

The increasing prevalence of FAs in adults represents a significant public health concern that merits comprehensive examination. Our retrospective study at the Ankara Bilkent City Hospital focused on the unique characteristics and prevalence of FAs in adults, revealing an actual prevalence rate of 0.31%, which is considerably lower than rates reported in various international studies.¹³⁻¹⁵ This discrepancy highlights the complex nature of FA recognition and diagnosis in adults, and it suggests that many cases may go unnoticed or misdiagnosed. One of the possible explanation for the lower prevalence observed in our study may be that patients with more severe allergic reactions are more likely to seek medical attention, while those experiencing milder symptoms may not pursue a formal diagnosis. In our cohort, a significant number of patients reported a history of anaphylaxis, which suggests that they tend to seek care mainly when confronted with severe reactions. Additionally, differences in diagnostic criteria among studies can significantly impact the reported prevalence of FAs. The EuroPrevall study showed that self-reported FA prevalence among adults in Europe ranged from 2% to 37%, whereas applying stricter diagnostic methods revealed a probable allergy prevalence of only 0.3% to 5.6%.³ In our study, the use of stringent diagnostic criteria limited our ability to identify FAs in adults with mild or atypical symptoms. This situation highlights that self-reported prevalence rates are often exaggerated, emphasizing the need for standardized diagnostic approaches to provide a more accurate understanding of FA prevalence and causative allergens.

The severity of allergic reactions noted in our study is particularly concerning, as a significant number of patients (81.8%) required emergency care and a relatively large number (72.7%) was diagnosed with anaphylaxis during their most recent allergic reaction. Despite a lower reported overall prevalence of FAs, the high rate of severe reactions emphasizes the urgency for healthcare providers to educate patients about recognizing symptoms and the critical need for immediate medical attention following exposure to allergens. This aligns with findings from the study which estimated that 51.1% of adults with FA in the United States reported experiencing at least one severe reaction throughout their lifetime, thereby underscoring the burden of severe FAs.¹⁶ Furthermore, our data indicate that a considerable number of patients required emergency care due to FA reactions; however, the rate of those possessing epinephrine was notably lower than optimal. Numerous studies from many different perspectives have shown that epinephrine is underused in the treatment of anaphylaxis, reflecting a gap in timely and effective management of severe allergic reactions.¹⁷ In a study examining FA in a large cohort of preschool-aged children, 11.4% of reactions were severe and only 29.9% of them were treated with epinephrine.¹⁸ This underscores the critical need for enhanced education and awareness surrounding FAs as well as the importance of prompt access to adrenaline for individuals at risk. The rapid onset of allergic symptoms, with a median time of just 10 minutes after consumption, further emphasizes the necessity for individuals with FAs to have access to autoinjectable epinephrine. Therefore, while our study reveals a relatively low prevalence of FAs,

the serious nature of reactions experienced by patients calls for intensified efforts in education, awareness, and treatment accessibility for FAs within the adult population.

Our findings indicate that adult-onset egg allergy represents a significant concern within our patient cohort, with this allergen identified in six patients (18.2%). The age of onset for egg allergy among these individuals spanned from 17 to 35 years, corroborating existing literature that indicates a trend of developing FAs in adulthood, particularly among individuals who previously tolerated the allergen.¹⁹ A salient finding from our study was the correlation between cooking methods and the manifestation of allergic symptoms. Specifically, while two patients experienced allergic reactions regardless of the cooking method, the remaining four patients demonstrated tolerance to well-cooked eggs, including fully boiled and baked products. This observation highlights the significant impact that thermal processing can have on the allergenic potential of egg proteins. Studies suggest that ovalbumin (Gal d 2), a major protein in egg white, is heat labile, allowing individuals with sensitization to this specific allergen to tolerate well-cooked eggs. Conversely, ovomucoid (Gal d 1), another allergenic component, is heat-stable and often associated with more severe allergic responses.²⁰ Our CRDs indicated that the patients who tolerated cooked eggs were specifically sensitized to ovalbumin but not ovomucoid, reinforcing the assertion that extensive avoidance of eggs may not be necessary for those with specific sensitizations. Overall, our study underscores the critical importance of component analysis in the management of adult-onset egg allergies to facilitate appropriate dietary recommendations and mitigate unnecessary restrictions.

Interestingly, while most adult-onset egg allergy cases in the literature are attributed to clear paths of sensitization, such as cross-reactivity with other allergens or environmental or occupational exposure,²¹⁻²⁴ the sensitization pathways in our case series were largely indeterminate. The absence of identifiable triggers, such as those associated with bird-egg syndrome or occupational exposure to egg aerosols, suggests the need for further investigation into the complex and often poorly understood mechanisms underlying adult-onset FAs. Current literature reveals only a limited number of documented cases of new-onset egg allergy in adults where the pathway of sensitization remains unclear.²⁵⁻²⁷ Our findings contribute to this expanding field of research and underscore the necessity for future investigations to explore the mechanisms that disrupt oral tolerance in adulthood, thereby deepening our understanding of adult FAs.

Our analysis also revealed significant findings related to fish, shellfish, and various nuts as contributors to allergic reactions. Fish and shellfish were responsible for 12.1% of the cases, highlighting the importance of acknowledging seafood allergies, which can lead to severe anaphylactic reactions. This is particularly relevant in coastal regions where fish and shellfish are dietary staples.^{28,29} Furthermore, the study noted a concerning trend in nut allergies, particularly with peanuts, which affected 6.1% of participants. This finding aligns with global data indicating a rise in peanut allergies, often exacerbated by cross-contamination in food preparation environments.³⁰ Interestingly, hazelnuts and almonds were implicated less frequently (3.0% each),

suggesting that while they are potential allergens, their prevalence may vary by geographic and demographic factors.³¹ The identification of fruits, particularly bananas and kiwis, as contributors to allergic reactions (each affecting 12.1% of participants) underscores the potential underrecognition of fruit allergies within clinical practice. Fruits are widely acknowledged for their health benefits and are often perceived as safe dietary options. However, this perception may lead to a lack of vigilance regarding their potential allergenic properties, particularly in susceptible individuals.^{32,33} The findings from our study emphasize the need for heightened awareness among healthcare providers to ensure they effectively educate patients about the risk of allergic reactions to these seemingly innocuous foods. Furthermore, this situation highlights the importance of comprehensive dietary evaluations when assessing patients with known allergies.

This study has several notable strengths that enhance its contribution to the field of FAs. First, it is one of the few studies focusing on adult-onset FAs within the Turkish population, providing valuable insights into a demographic that is often underrepresented in existing literature. Additionally, our findings contribute to the growing literature on FAs and highlight the importance of ongoing research in this area, particularly regarding the breakdown of tolerance and management of FAs in adulthood. By highlighting the need for nuanced dietary recommendations based on component sensitization, our work may inform future guidelines for healthcare providers managing patients with FAs.

Our study presents some limitations. First, the retrospective design of the study may have introduced biases related to data collection, as it relies on the accuracy and completeness of medical records and patient-reported information. Additionally, the sample size of 33 patients diagnosed with FAs may limit the generalizability of our results to a broader adult population. While we employed a comprehensive diagnostic approach, the reliance on sIgE testing and SPTs may not capture all individuals with FAs, particularly those with only mild or atypical symptoms. This could result in an underestimation of the actual prevalence of FAs within our cohort. Furthermore, the lack of long-term follow-up for patients may limit our understanding of the natural history of FAs, including the persistence or resolution of allergic sensitivities over time. As the diagnosis of FAs often requires repeated assessments and challenges, the retrospective nature of our study does not allow for ongoing monitoring of changes in sensitization or tolerance. Finally, variations in the management and treatment of allergic reactions across different healthcare providers could influence the outcomes reported in our study. Patient education regarding the use of epinephrine and the recognition of anaphylaxis symptoms may also vary, potentially affecting the frequency and severity of allergic reactions observed.

Conclusions

In conclusion, our study reveals a prevalence rate of 0.31% for FAs among adults, which while lower than many international reports, highlights significant concerns regarding the

clinical presentation of allergies. Notably, allergens such as shellfish, tree nuts, and fruits like bananas and kiwis were frequently identified, with adult-onset egg allergy raising particular concern due to its complex symptomatology. A striking 72.7% of patients who experienced severe reactions required emergency intervention for anaphylaxis, emphasizing the critical need for improved awareness and recognition of FA symptoms among healthcare providers. This study illustrates the importance of continued research and education to enhance the management strategies for FAs within the adult population, despite the lower prevalence compared to other regions.

Statement of Ethics

This study was conducted in accordance with the Declaration of Helsinki and approved by the Ethics Committee of Ankara Bilkent City Hospital (Approval no: TABED 2-24-445; Approval date: 04.09.2024). The authors declare that they have followed the protocols of their work center on the publication of patient data and that the patients included in the study received sufficient information and gave their informed consent in writing to participate in that study.

Authors Contribution

BÖÖ: conceptualized and designed the study, conducted data collection and analysis. BGA and MSBD: conducted data collection and analysis. ŞS: supervised the study. All authors contributed to the writing of the manuscript, interpreted the results, and gave final approval.

Conflicts of Interest

The authors have no conflicts of interest to declare.

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