

Parent report of physician diagnosis in pediatric food allergy

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Background: Childhood food allergy is a serious health problem. However, little is known about the frequency and manner in which it is currently diagnosed.

Objective: To describe parent report of physician practices in the diagnosis of pediatric food allergy.

Methods: Data from children with food allergy were identified for analysis from a representative survey administered in US households with children from June 2009 to February 2010.

Analyses were performed at the level of the allergy.

Demographic characteristics, symptom prevalence, and diagnostic methods were calculated as weighted proportions.

Adjusted models were estimated to examine the association of reaction history and allergenic food with odds of physician diagnosis and testing.

Results: Food allergies (n = 3,218) to 9 common allergens were reported among 2,355 children in a sample of 38,480. We found that 70.4% of reported food allergy was diagnosed by a physician. Among physician-diagnosed food allergy, 32.6% was not evaluated with diagnostic testing, 47.3% was assessed with a skin prick test, 39.9% with a serum specific IgE test, and 20.2% with an oral food challenge. Odds of physician diagnosis and testing were significantly higher for severe versus mild/moderate food allergy. Urticaria and angioedema were not reported as symptoms in 40.7% and 34.6% of severe food allergies, respectively.

Conclusion: Thirty percent of parent-reported food allergies in this study were not diagnosed by a physician. One in 5 physician-diagnosed allergies was evaluated with oral food challenge. Understanding parent report of practices in food allergy provides insight into ways in which to streamline the diagnosis and management of care. (*J Allergy Clin Immunol* 2012;■■■■:■■■-■■■.)

Key words: Food allergy, diagnosis, oral food challenge, serum specific IgE, skin prick test, pediatrics, urticaria, angioedema, eczema

Abbreviation used

OFC: Oral food challenge

Childhood food allergy is a serious and growing health problem in the United States. An estimated 5.9 million American children experience food allergy,¹ an increase of $\geq 18\%$ during the past decade.²⁻⁵ Among affected children, nearly 40% have a history of severe reactions, ranging from a sudden hypotension to a life-threatening anaphylactic event.¹ Food-induced anaphylaxis is the most common type of anaphylaxis treated in emergency departments in the United States and is an appreciable source of morbidity and mortality.^{6,7} These data are particularly troubling, given the absence of a cure, limited treatment options, and the ubiquity of food in our society.

Consistent and appropriate diagnosis of food allergy is critical to keep affected children safe while preventing unnecessary avoidance. Unfortunately, few data exist that describe current practices in the United States. Studies suggest that parents are often frustrated by divergent medical opinion about their child's food allergy.^{8,9} Indeed, it has been shown that few primary care physicians feel comfortable interpreting laboratory tests to diagnose food allergy or feel adequately prepared by their medical training to care for children with food allergy.¹⁰ It has also been suggested that minority and low-income children may be less likely to receive a formal diagnosis of food allergy, even when a convincing allergy exists.^{1,2}

Beyond the latter data, however, little is known about the frequency and manner in which various diagnostic approaches are used in the care of children with food allergy. To standardize care and identify opportunities for improvement, it is critical to understand where current practice falls with respect to national food allergy guidelines.¹¹ The goal of this study was to describe parent report of physician practices in the diagnosis of pediatric food allergy as well as parents' characterization of their child's clinical presentation with the use of data from a large, representative sample of US households with children.

METHODS

Data from a representative sample of children with current food allergy were identified for analysis from a randomized, cross-sectional survey of US households with children conducted between June 2009 and February 2010. The institutional review boards of Children's Memorial Hospital and Northwestern University in Chicago approved the study protocol. Consent to participate was implicit in completion and return of the survey.

Survey development and design

The survey was developed by pediatricians, pediatric allergists, and health services researchers, with support of an expert panel comprised of leaders in the field. For a detailed description of survey methods, see Gupta et al.¹ The final survey was administered electronically and is available on request. Items assessed parent report of a child's food allergies, including date of onset, method of diagnosis, and reaction history for each reported allergen as well

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as detailed demographic information. Data were not collected on suspected food allergy ruled out by a physician.

Study participants and recruitment

Eligible participants included adults (≥ 18 years) able to complete the survey in Spanish or English residing in US households with at least 1 child younger than 18 years. Participants were instructed to complete the survey for a child in their household randomly selected by computer algorithm. Recruitment was conducted with a dual-sample approach, in which a probability-based sample statistically representative of US households with children was used to identify and correct for sampling and nonsampling bias introduced by a larger, opted in online sample. Recruitment and weighting schemes are described in depth in Gupta et al.¹

Outcome measures

Data were analyzed for the 9 allergens most frequently reported: egg, fin fish, milk, peanut, sesame, shellfish, soy, tree nut, and wheat. Only food allergies reported to induce one or more of the following reaction symptoms were included in the analysis: anaphylaxis (defined as a severe allergic reaction that can lead to death), angioedema of lips/eyes/face, other angioedema, coughing, other oropharyngeal symptoms, eczema, flushing, hives, low blood pressure, pruritus, trouble breathing, vomiting, or wheezing.

Allergies were analyzed on the basis of diagnostic and reaction history. Diagnostic history included whether the allergy was physician-diagnosed and whether serum-specific IgE testing (blood test), skin prick testing (skin test), and/or oral food challenge (OFC) had been used to assess the allergy. Reaction history included age at first reaction, history of seasonal allergies or multiple food allergies (both potential comorbid conditions), and severity of reaction by reported symptom. Mild-moderate symptoms were limited to angioedema of lips/eyes/face, other angioedema, coughing, other oropharyngeal symptoms, eczema, flushing, hives, pruritus, and vomiting. Severe symptoms included any report of anaphylaxis, low blood pressure, trouble breathing, or wheezing. A reaction that included vomiting, angioedema, and coughing in combination was also categorized as severe.

Statistical analysis

Data were weighted with the use of both base and poststratification weights to adjust for potential biases from sampling design and survey response as described in Gupta et al.¹ Analyses were performed at the level of the allergy; subjects with multiple food allergies had multiple observations. Demographic characteristics, symptom prevalence, and diagnostic history were calculated as weighted proportions.¹² Multiple logistic regression models, adjusted for multiple observations per subject, survey design, and sample weights, were estimated to examine the association of reaction history and allergenic food with the odds of having a physician diagnosis, blood test, skin test, or OFC. Separate models were estimated for each outcome. Each model was adjusted for household income, race/ethnicity, age of reaction, geographic region, sex, severity of allergy, report of seasonal allergies, and report of multiple allergies. All analyses were estimated with the use of Stata 11.0 (StataCorp, College Station, Tex).

RESULTS

Data were collected for 40,104 children. Incomplete responses for 1624 children were not included in the analysis. From the final sample of 38,480 children, 3,218 food allergies were identified and analyzed for 9 common allergens among 2,355 children.

Demographic characteristics

Demographic characteristics of food allergy are presented in Table I, broken down by report of physician diagnosis. Significant difference was observed in the distribution of food allergy by race/

TABLE I. Demographic distribution of FA characterized by report of physician diagnosis

Variable	Reported FA, undiagnosed	Reported FA, diagnosed	P value
Race/ethnicity			>.001*
Asian, non-Hispanic	11.5 (8.4-15.5)	5.6 (4.2-7.5)	
Black, non-Hispanic	27.0 (22.3-32.4)	20.4 (17.5-26.6)	
White, non-Hispanic	39.2 (34.8-43.8)	52.7 (49.3-56.1)	
Hispanic	19.6 (15.6-24.3)	18.0 (15.2-21.1)	
Multiple/other	2.6 (1.8-3.8)	3.3 (2.5-0.5)	
Sex			.6893
Female	47.0 (41.2-51.9)	48.1 (44.8-51.5)	
Male	53.0 (48.1-57.9)	51.9 (48.5-55.2)	
Age			.2793
0-2 y	13.2 (10.4-16.5)	12.1 (10.2-14.3)	
3-5 y	20.4 (16.2-25.2)	20.4 (17.8-23.3)	
6-10 y	23.7 (19.7-28.3)	26.7 (23.9-29.7)	
11-13 y	17.5 (14.3-21.3)	20.1 (17.5-23.1)	
14-17 y	25.2 (21.2-29.8)	20.7 (18.2-23.4)	
Household income, \$			.0195*
<25,000	16.3 (12.8-20.4)	14.4 (12.0-17.1)	
25,000-49,999	30.9 (26.2-36.2)	24.2 (21.4-27.4)	
50,000-99,999	34.9 (30.6-39.5)	37.5 (35.0-40.7)	
100,000-149,999	10.4 (8.0-13.5)	15.7 (13.5-18.3)	
$\geq 150,000$	7.5 (4.9-11.1)	8.1 (6.5-10.1)	

Values are means (95% CIs).

FA, Food allergy.

*Statistically significant distribution between diagnosed and undiagnosed FA ($P < .05$).

TABLE II. Demographic distribution of physician-diagnosed food allergy characterized by report of diagnostic test

Variable	Blood test	Skin test	OFC
Race/ethnicity			
Asian, non-Hispanic	6.0 (3.6-9.9)	7.5 (5.0-10.9)	6.6 (3.0-13.7)
Black, non-Hispanic	18.5 (14.3-23.7)	18.3 (14.4-23.0)	19.8 (13.6-28.0)
White, non-Hispanic	55.9 (50.4-61.2)	54.3 (49.4-59.0)	53.5 (45.8-61.0)
Hispanic	16.0 (12.0-20.9)	16.6 (12.9-21.0)	16.4 (11.4-22.9)
Multiple/other	3.6 (2.3-5.6)	3.4 (2.3-5.2)	3.7 (1.9-7.1)
Sex			
Female	43.0 (37.9-48.3)	46.6 (41.9-51.3)	47.8 (40.4-55.2)
Male	57.0 (51.8-62.1)	53.3 (48.7-58.1)	52.3 (44.8-59.6)
Age			
0-2 y	9.4 (7.0-12.4)	9.6 (7.2-12.6)	12.3 (8.2-18.1)
3-5 y	23.8 (19.6-28.6)	22.1 (18.3-26.4)	21.0 (15.3-28.0)
6-10 y	27.7 (23.2-32.7)	26.8 (22.9-31.2)	25.4 (19.5-32.4)
11-13 y	21.0 (16.8-25.9)	21.3 (17.6-25.6)	20.2 (14.6-27.3)
14-17 y	18.1 (14.8-22.1)	20.2 (16.9-24.0)	21.1 (16.0-27.3)
Household income, \$			
<25,000	10.8 (7.7-15.0)	8.7 (6.3-11.8)	13.0 (8.4-19.5)
25,000-49,999	21.2 (17.2-26.8)	17.8 (14.5-21.7)	25.1 (19.2-32.2)
50,000-99,999	38.7 (33.8-43.7)	42.7 (38.2-47.4)	36.0 (29.5-43.0)
100,000-149,999	18.4 (14.5-23.0)	19.9 (16.4-24.1)	16.6 (11.9-22.8)
$\geq 150,000$	11.0 (8.0-14.9)	10.9 (8.1, 14.5)	9.3 (5.1-16.2)

Values are means (95% CIs).

Note that categories are not mutually exclusive, that is, a parent may have reported multiple tests for a given allergy.

ethnicity and household income. For example, 11.5% and 27.0% of undiagnosed food allergy occurred among Asian and black children, respectively, compared with 5.6% and 20.4% of diagnosed food allergy. In contrast, 52.7% of diagnosed food allergy

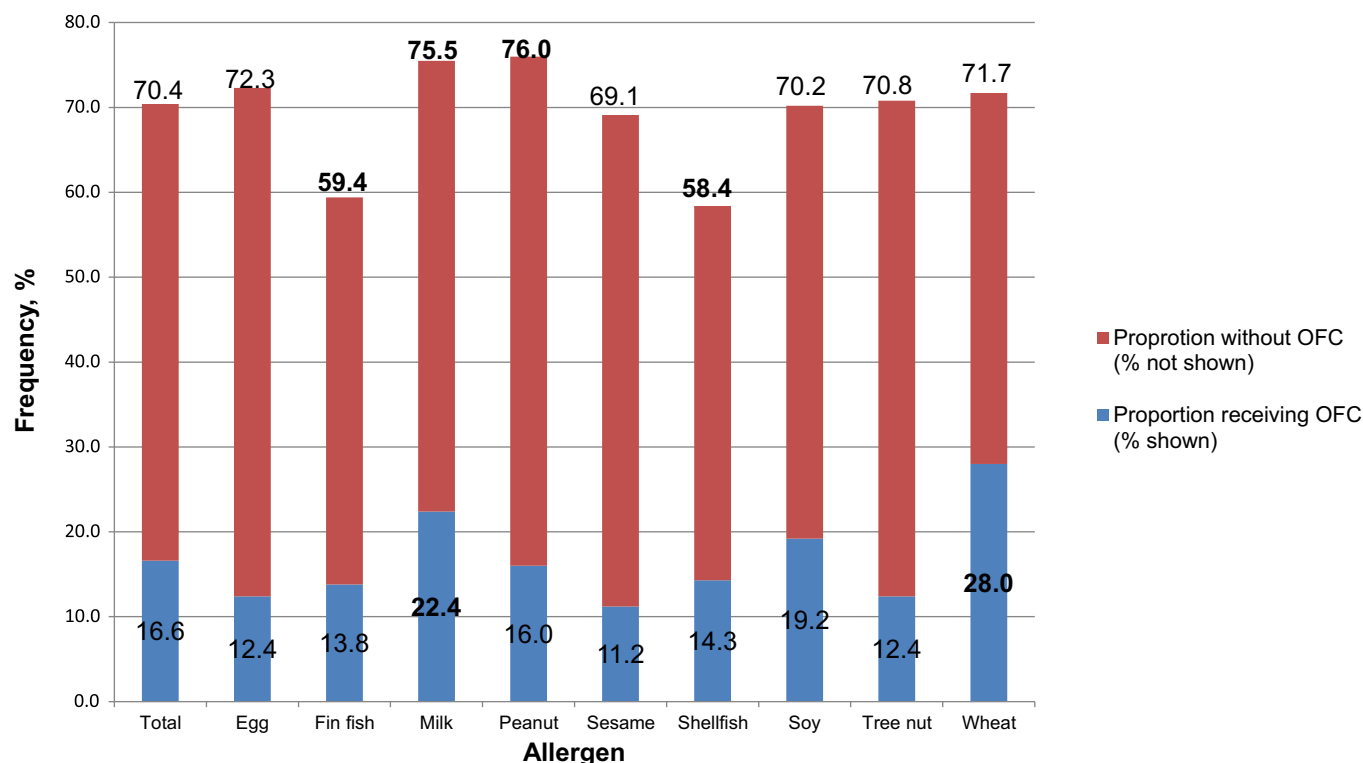


FIG 1. Frequency of reported physician diagnosis overall and by allergen (% above bar). The proportion of diagnosed food allergy evaluated with OFC is shown. For example, among cases of reported egg allergy, 72.3% were reported as physician-diagnosed. Among these cases, 12.4% were reported to have been evaluated with OFC. Bolded values indicate significant difference from total ($P < .05$).

occurred among white children, compared with 39.2% of undiagnosed food allergy.

Diagnostic history

Seventy percent of reported food allergy was physician-diagnosed (70.4%; 95% CI, 67.9-72.7). Among physician-diagnosed food allergy, 47.3% of food allergy was assessed with a skin test (95% CI, 35.9-43.9), 39.9% with a blood test (95% CI, 35.9-43.9), and 20.2% with an OFC (95% CI, 17.7-23.0). Diagnostic testing was not reported in 32.6% (95% CI, 28.8-36.7) of physician-diagnosed food allergy. Note that diagnostic approaches were not mutually exclusive (eg, a parent was able to report a physician diagnosis with or without any combination of blood test, skin test, or OFC).

Demographic characteristics by diagnostic approach are presented in Table II. (Note that the pattern of distribution tends to mirror the overall distribution of diagnosed food allergy reported in Table I.) Fig 1 presents the allergen-specific frequency of physician-diagnosis as well as the proportion of diagnosed food allergies evaluated with OFC.

Reaction history

An allergen was reported to induce multiple symptoms in 56.7% of cases (95% CI, 53.3-60.1) and to occur in conjunction with another food allergy(s) in 49.3% of cases (95% CI, 45.4-53.1). Table III characterizes symptoms and age of first reaction overall and by allergen. The 3 most frequently reported presenting

symptoms in both diagnosed and undiagnosed food allergy were urticaria, angioedema, and eczema, in that order.

Not shown in Table III, urticaria (50.7%; 95% CI, 42.6-58.7) and angioedema (44.9%; 95% CI, 37.1-53.0) were also among the 3 most common presenting symptoms in food allergy confirmed by OFC, along with wheezing (41.4%; 95% CI, 33.9-49.2). However, report of cutaneous symptoms was not prerequisite for report of potentially life-threatening reactions. Urticaria and angioedema were absent in 40.7% (95% CI, 37.1-44.3) and 34.6% (95% CI, 31.7-37.6) of severe food allergies, respectively.

Associations

Odds of reporting a physician-diagnosis and/or some form of clinical testing are presented in Table IV. Odds of physician diagnosis, blood and skin testing, and OFC were all significantly higher for food allergy characterized as severe compared with mild/moderate on the basis of parent report of symptoms. Reporting more than one food allergy was also associated with higher odds of blood testing, skin testing, and OFC. Peanut, milk, and tree nut had significantly higher odds of a report of physician diagnosis than other allergenic foods. However, only milk (as well as wheat) had higher odds of confirmation with OFC. Peanut and tree nut allergies had significantly higher odds of assessment with blood testing; tree nut had higher odds of skin testing as well. Shellfish and fin fish allergies had significantly lower odds of physician diagnosis; shellfish allergy was also significantly less likely to be assessed with blood or skin testing.

TABLE III. Presentation of FA by allergen, characterized by report of physician diagnosis

Variable	All FA	Peanut	Milk	Tree nut	Shellfish
Reported FA, undiagnosed	(n = 938)	(n = 167)	(n = 171)	(n = 123)	(n = 207)
Mean age at first reaction	4.3 (4.0-4.6)	3.9 (3.3-4.4)	3.0 (2.4-3.6)	3.7 (2.5-5.0)	3.0 (2.4-3.6)
Presenting symptoms					
Urticaria	41.4 (37.0-46.0)*	44.9 (35.7-54.4)*	27.7 (19.5-37.6)*	38.6 (28.4-49.9)*	52.9 (43.9-61.6)*
Eczema	28.9 (24.4-33.9)*	34.1 (25.6-43.7)*	39.1 (30.2-48.8)*	19.4 (11.2-31.5)	16.2 (10.2-24.6)
Wheezing	14.7 (11.7-18.5)	16.8 (11.0-24.9)	11.5 (7.0-18.5)	16.1 (8.6-27.9)	11.9 (7.1-19.2)
Hypotension	2.5 (1.2-5.7)	2.2 (0.8-6.3)	1.3 (0.3-5.5)	2.0 (0.3-12.6)	3.9 (1.3-11.4)
Anaphylaxis	3.3 (2.0-5.3)	3.4 (1.0-10.6)	2.6 (0.6-10.1)	1.9 (0.6-5.8)	5.5 (2.6-11.1)
Trouble breathing	19.1 (15.5-23.4)	24.1 (17.0-33.1)	7.7 (3.5-15.9)	23.8 (15.3-34.9)*	24.7 (17.2-34.2)*
Angioedema*	32.6 (28.3-37.3)*	42.8 (33.7-51.4)*	9.0 (4.4-17.5)	46.8 (35.9-52.5)*	44.1 (35.5-53.2)*
Coughing	13.5 (10.6-17.0)	14.6 (9.3-22.3)	21.2 (14.2-30.4)*	13.9 (7.3-24.9)	9.0 (4.9-15.9)
Reported FA, diagnosed	(n = 2280)	(n = 587)	(n = 486)	(n = 303)	(n = 292)
Mean age at first reaction	3.7 (3.5-3.0)	3.6 (3.3-3.9)	2.2 (1.9-2.5)	4.0 (3.1-4.9)	5.8 (5.3-6.4)
Presenting symptoms					
Urticaria	58.1 (55.2-60.9)*	68.8 (63.8-73.3)*	38.1 (33.0-42.4)*	60.1 (53.1-66.8)*	61.8 (54.8-68.4)*
Eczema	31.9 (29.1-34.7)*	25.7 (21.5-30.3)	34.0 (9.0-39.3)*	20.4 (15.5-26.4)	35.4 (28.8-42.5)
Wheezing	31.0 (28.4-33.8)	37.2 (32.5-42.2)	23.7 (19.4-28.6)	27.4 (21.9-33.7)	35.8 (29.4-42.9)
Hypotension	7.1 (5.7-8.7)	6.9 (4.8-9.9)	5.3 (3.3-8.4)	5.7 (3.3-9.9)	8.3 (5.2-12.9)
Anaphylaxis	12.2 (10.5-14.1)	17.6 (14.1-21.6)	4.4 (2.9-6.6)	15.6 (11.3-21.1)	13.0 (8.9-18.5)
Trouble breathing	31.1 (28.5-33.9)	38.7 (34.0-43.8)*	19.9 (15.8-24.8)	35.9 (29.4-42.9)*	39.8 (33.0-46.9)*
Angioedema†	41.5 (38.8-44.4)*	57.0 (52.0-61.9)*	20.3 (16.2-25.1)*	45.5 (38.8-52.5)*	62.8 (55.8-69.2)*
Coughing	16.9 (14.7-19.5)	18.3 (14.7-22.4)	18.7 (14.8-23.4)	15.2 (11.2-20.3)	13.9 (9.8-19.2)

Values are means (95% CIs).

FA, Food allergy.

*The 3 most common reported symptoms for each allergen.

†Angioedema of lips, eyes, or face.

TABLE III. (Continued)

Variable	Egg	Fin fish	Wheat	Soy	Sesame
Reported FA, undiagnosed	(n = 73)	(n = 78)	(n = 40)	(n = 47)	(n = 32)
Mean age at first reaction	2.0 (1.6-2.5)	5.0 (3.9-6.1)	5.3 (3.5-7.1)	5.4 (4.7-7.0)	4.1 (2.9-5.4)
Presenting symptoms					
Urticaria	26.8 (16.7-40.0)*	54.5 (40.6-67.8)*	32.4 (16.7-53.5)*	33.2 (18.4-52.4)*	47.3 (25.4-70.3)*
Eczema	37.3 (24.1-2.6)*	32.4 (20.4-47.3)*	56.1 (37.0-73.5)*	24.2 (13.1-40.4)*	11.4 (4.1-28.2)
Wheezing	8.6 (3.0-22.5)	18.6 (9.3-33.7)	21.6 (10.1-40.4)	18.2 (6.9-40.2)	27.6 (10.4-56.0)*
Hypotension	0.00	5.9 (1.5-20.3)	0.00	1.9 (0.3-12.7)	2.8 (0.7-11.2)
Anaphylaxis	0.00	2.9 (0.7-10.9)	7.4 (1.1-37.1)	1.9 (0.3-12.7)	0.00
Trouble breathing	7.3 (2.1-22.8)	24.3 (13.7-39.3)	22.8 (9.8-44.3)*	11.2 (4.0-27.9)	8.8 (2.8-24.3)
Angioedema*	12.7 (6.3-24.0)*	39.7 (27.1-54.0)*	17.6 (6.2-40.8)	13.8 (5.2-31.8)	30.3 (12.1-57.8)*
Coughing	7.8 (3.7-15.6)	12.8 (5.7-26.2)	12.8 (5.7-26.2)	18.7 (7.7-38.8)*	6.9 (1.5-26.3)
Reported FA, diagnosed	(n = 217)	(n = 107)	(n = 124)	(n = 109)	(n = 55)
Mean age at first reaction	2.8 (2.3-3.2)	4.9 (4.1-5.7)	4.2 (3.4-4.9)	3.6 (2.9-4.2)	4.9 (4.0-5.9)
Presenting symptoms					
Urticaria	66.4 (58.5-73.5)*	57.0 (45.9-67.3)*	52.0 (41.3-62.5)*	59.3 (47.3-70.3)*	60.9 (45.0-74.8)*
Eczema	34.1 (26.8-42.3)*	38.4 (28.2-49.7)*	48.8 (38.3-59.4)*	46.0 (34.3-58.1)*	39.8 (25.8-55.7)*
Wheezing	23.6 (17.6-30.9)	30.5 (21.6-41.1)	24.3 (16.1-34.9)*	39.7 (28.1-52.6)*	45.0 (30.3-60.7)*
Hypotension	7.5 (4.3-12.9)	13.5 (8.0-21.9)	5.4 (2.5-11.1)	4.7 (1.9-11.0)	16.5 (8.6-29.3)
Anaphylaxis	5.2 (3.0-8.9)	17.0 (10.7-26.1)	7.3 (3.5-14.3)	12.7 (7.4-21.1)	23.1 (13.3-37.0)
Trouble breathing	20.8 (15.2-27.8)	29.2 (20.3-40.0)	24.8 (16.4-25.7)	30.4 (19.8-43.5)	27.9 (17.1-42.2)
Angioedema†	29.4 (22.8-37.0)*	47.3 (36.4-58.5)*	20.5 (12.6-31.6)	21.8 (13.2-3.8)	26.9 (16.0-41.6)
Coughing	14.4 (9.6-21.0)	13.3 (7.3-23.0)	18.2 (11.5-27.6)	20.5 (12.0-32.7)	23.0 (12.8-38.0)

DISCUSSION

Thirty percent of reported food allergies in this study were not diagnosed by a physician. Among physician-diagnosed food allergies, 1 in 5 was confirmed with an OFC. Physician diagnosis and OFC were more likely for allergens that had induced severe reactions in the past according to parent report of symptoms. Variation was seen by allergen as well. Peanut, tree nut, and milk had the greatest odds of a reported physician diagnosis. Only milk

and wheat had significantly higher odds of reported OFC than other allergens. Shellfish allergy, known to elicit severe reactions,¹³ was significantly less likely than other allergies to be reported as physician-diagnosed or evaluated with blood or skin testing.

In this study, urticaria, angioedema, and eczema were the most commonly reported presenting symptoms for both diagnosed and undiagnosed food allergy, although other reactions may have been more common for specific foods. Cutaneous symptoms

TABLE IV. Multiple logistic regression models: odds of physician diagnosis and diagnostic testing

Variable	Physician Dx	Blood test	Skin test	OFC
Severe vs mild/moderate FA	2.3 (1.6-3.4)*	2.0 (1.5-2.7)*	1.4 (1.1-2.0)*	2.2 (1.5-3.3)*
Seasonal allergy vs not	1.3 (1.0-1.7)*	0.9 (0.7-1.2)	1.1 (0.9-1.5)	1.1 (0.8-1.6)
Multiple FA vs not	1.1 (0.9-1.5)	1.5 (1.1-1.9)*	1.5 (1.1-1.9)*	1.4 (1.0-1.9)*
Age at first reaction vs 0-2 y				
3-5 y	0.9 (0.7-1.2)	0.9 (0.7-1.2)	1.1 (0.8-1.5)	0.9 (0.6-1.3)
6-10 y	1.2 (0.8-1.7)	1.0 (0.7-1.5)	1.0 (0.7-1.4)	1.3 (0.8-1.9)
11-13 y	0.4 (0.2-0.9)*	0.6 (0.3-1.3)	0.9 (0.4-1.8)	1.7 (0.8-3.5)
14-17 y	0.8 (0.4-1.7)	0.4 (0.2-1.1)	0.6 (0.2-1.8)	0.4 (0.1-1.1)
Food allergen				
Peanut vs not	1.3 (1.0-1.8)*	1.3 (1.0-1.7)*	1.1 (0.9-1.3)	1.1 (0.8-1.5)
Milk vs not	1.6 (1.2-2.2)*	0.8 (0.6-1.1)	0.8 (0.6-1.1)	1.5 (1.1-2.2)*
Tree nut vs not	2.2 (1.1-4.2)*	2.0 (1.1-3.5)*	3.9 (2.1-7.2)*	0.6 (0.3-1.6)
Shellfish vs not	0.5 (0.4-0.7)*	0.5 (0.4-0.7)*	0.6 (0.4-0.8)*	0.9 (0.6-1.3)
Egg vs not	1.2 (0.9-1.8)	1.2 (0.9-1.7)	1.7 (1.2-2.3)*	0.8 (0.5-1.4)
Fin fish vs not	0.5 (0.4-0.8)*	0.8 (0.5-1.3)	0.9 (0.6-1.4)	0.6 (0.3-1.1)
Wheat vs not	1.1 (0.7-1.7)	1.7 (1.1-2.6)*	1.4 (1.0-2.1)	1.9 (1.1-3.3)*
Soy vs not	0.9 (0.6-1.4)	0.8 (0.4-1.4)	0.7 (0.4-1.1)	1.0 (0.5-1.8)
Sesame vs not	1.2 (0.7-2.2)	1.4 (0.8-2.4)	1.1 (0.6-1.9)	0.4 (0.2-1.1)

Values are odds ratios (95% CIs).

Adjusted for household income, race/ethnicity, age of reaction, geographic region, sex, severity of allergy, report of seasonal allergies, and report of multiple allergies.

Dx, Diagnosis; FA, food allergy.

*Statistically significant ($P < .05$).

are consistently recognized as common manifestations of food-induced reactions^{14,15} and have been reported to be present in 80% of *carefully* assessed anaphylactic reactions.¹⁵ However, it is critical to acknowledge that cutaneous symptoms can be absent or may not be recognized by parents. Indeed, urticaria and angioedema were not reported for 40.7% and 34.6% of severe reactions in this study, respectively. The absence or unnoticed manifestation of physically visible symptoms may preclude prompt recognition of a severe reaction, putting a child at increased risk for adverse outcomes. Thus, physician involvement in the management of food allergy is critical to educate parents about the various ways in which a food-induced reaction may present.

Approximately 30% of reported food allergies in this study were not physician-diagnosed. This result is similar to that of Luccioli et al,¹⁶ who found that nearly 34% of infants with probable food allergy as reported by the mother lacked a physician diagnosis. It is possible that, when a food allergy is suspected, parents may simply have their child avoid a specific food without consulting a physician. Although this may seem logical to a parent, it can be detrimental for the child. As suggested above, the absence of physician diagnosis can result in poor understanding of the risks of food allergy, including the fact that previous reactions do not necessarily predict severity of future reactions.¹¹ Furthermore, without a formal diagnosis, the child may not have access to life-saving medications (ie, injectable epinephrine), resulting in increased risk of severe reactions or death with accidental exposures.¹¹ Finally, it is possible that the parents have mistaken the causative food, which could lead to unnecessary food avoidance affecting nutrition and quality of life, while conversely increasing the risk of having a reaction to the true food allergen.

The diagnosis of food allergy can be challenging because of the diversity of symptoms, different immunologic mechanisms (IgE versus non-IgE), parent confusion of allergy versus intolerance, and the poor positive predictive value of testing when not

correlated with clinical symptoms.¹¹ Further complicating the issue, children may be able to ingest extensively heated food allergens, particularly cow's milk and egg, without symptoms but will react to uncooked or partially cooked forms of the allergen.^{17,18}

In an attempt to standardize best clinical practices, "Guidelines for the Diagnosis and Management of Food Allergy in the United States" was released by the National Institute of Allergy and Infectious Disease-sponsored expert panel in 2010.¹¹ The diagnosis of food allergy depends on medical history, which includes symptoms, timing of reaction (immediate versus delayed), type (cooked/uncooked) and amount of specific food ingested, and consistency of reactions (episodes occurring every time a food is ingested). However, history alone is not diagnostic of food allergy and must be combined with testing for food-specific IgE (in the case of IgE-mediated reactions) and/or an OFC, which is the "gold standard."

Physician-diagnosed food allergy was reported to be assessed with skin prick and serum-specific IgE testing in 47.3% and 39.9% of cases, respectively. The reported percentage of skin prick testing among children is close to that of a survey of 4,482 US adults conducted by the Food and Drug Administration in 2001. Here, among 279 adults with self-reported physician-diagnosed food allergy, skin testing and blood testing were used in 46.4% and 10.2% of cases, respectively. Data on the use of OFC were not reported.¹⁹ In our study, a history of severe food-allergic reactions and multiple food allergies significantly increased the odds of reported testing (both skin and blood) and OFC, none of which were mutually exclusive. In the case of severe reactions, the odds of reported physician diagnosis were more than double that of mild/moderate reactions. These results are not surprising, because parents may have increased awareness of food allergies and be more likely to consult a physician in cases of severe reactions or multiple food allergies. Both skin and blood testing for specific IgE identify sensitization, are sensitive, and have a high negative predictive value. However, the tests are not specific. (For a more detailed review of test characteristics, see Lieberman

et al.²⁰) Because false positive tests are not uncommon, the diagnosis of food allergy requires that tests be correlated with a history consistent with a food allergic reaction.^{11,21} In some cases, when the history is complicated by the ingestion of multiple foods to which the child is sensitized, an OFC should be considered to correctly identify the allergen or allergens of significance.

Twenty percent of diagnosed food allergy was reported as confirmed with an OFC. This number seems comparable with that reported in the afore-mentioned infant study, in which 19.5% of infants with a maternal report of a food-related problem underwent a food challenge.¹⁶ However, neither our study nor the infant study evaluated the use of OFCs as a means to rule out food allergy. Therefore, it is possible that food challenges are used in greater frequency than reported herein. Nevertheless, there are multiple reasons an OFC may not be used to confirm a diagnosis of food allergy, which may contribute to the frequency of use reported in our study.

In some cases, an OFC is not indicated because the risk may outweigh the benefit. For example, if a child has an anaphylactic reaction within minutes of ingesting peanut and is subsequently found to be sensitized to the allergen by skin or blood testing, proceeding with an OFC may not be warranted. In cases of non-IgE-mediated food allergy, such as food protein-induced enterocolitis, or mixed IgE and non-IgE-mediated conditions such as eosinophilic esophagitis, an elimination diet with resolution of symptoms combined with a typical clinical history may be sufficient evidence of food allergy.

When an OFC is indicated, availability is a limitation to use. Physicians, generally specialists in allergy/immunology with sufficient experience in food allergy, should perform oral challenges. A 2005 physician survey found that 73% of allergists and 36.4% of nonallergists performed OFC to verify a food allergy.²² Many private practice physicians do not perform or infrequently perform oral challenges in their offices because of a number of barriers. To this end, a recent study by Pongracic et al²³ highlighted a discrepancy in the number of OFCs being performed by allergists, citing concerns about time constraints, poor reimbursement, the risk of adverse events, and a lack of dedicated resources. As a result of these barriers, children are often referred to pediatric hospitals, where the waiting list for an OFC has been observed to be longer than 18 months in some instances. Further, parents may be unwilling to have their child undergo an OFC because of safety concerns, especially if the child has experienced a food-induced anaphylactic reaction. In addition, as mentioned earlier, parents may implement restriction diets without mentioning a child's allergy to the physician; as such, the parents will likely be unaware that OFCs are available.

The main limitation of this study is self-report of food allergy reaction history and diagnosis, which is subject to recall bias and misinterpretation by the parent. In addition, data on the reproducibility of reaction symptoms were not collected, and the survey was not validated to ensure accuracy of diagnosis. Data were also not collected on suspected food allergy ruled out by a physician. Therefore, a food allergy may have been reported by a parent without report of physician diagnosis but may well have been appropriately evaluated. We were also unable to assess motivations for testing or not testing from the perspective of either the parent or the physician. Finally, because the study was designed as a survey, biologic samples were not collected and immunologic mechanisms could not be assessed.

Conclusion

In the United States, food allergies affect all races/ethnicities across the economic spectrum. The majority of reported food allergy is diagnosed by a physician and is associated with some form of testing. However, 30% of parent-reported food allergy in this study was not diagnosed by a physician. One in 5 physician-diagnosed allergies was evaluated with the use of an OFC. True food allergy that goes undiagnosed or diagnosed food allergy that is not appropriately substantiated places children at increased risk for poor outcomes. Accordingly, a better understanding of parent-reported practices in the diagnosis of pediatric food allergy provides insight into ways in which to streamline the management of disease to keep affected children safe.

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Clinical implications: Food allergy reported by a parent may not receive a formal physician diagnosis. Among diagnosed food allergy, oral food challenge is not frequently reported.

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