

Children Covered by Medicaid/State Children's Health Insurance Program More Likely to Use Emergency Departments for Food Allergies

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Background: Food allergies (FAs) occur in 4% to 8% of children in the United States, and emergency department (ED) visits account for up to 20% of their costs. In 2010, the National Institute of Allergy and Infectious Diseases established diagnostic criteria and management practices for FAs, and recognition and treatment of FAs for pediatric ED practitioners has been described.

Objective: This study identified trends and factors related to ED visits for pediatric FAs in the United States from 2001 to 2010. It was hypothesized that FAs increased and that differences existed in ED utilization based on age, insurance status, and geography. Low concordance with treatment guidelines for FAs was expected.

Methods: Multivariate logistic regression, using National Hospital Ambulatory Medical Care Survey data, estimated factors associated with ED visits and treatment of FAs and nonspecific allergic reactions. Trends and treatment patterns used weighted frequencies to account for the complex 4-stage probability survey design.

Results: An estimated 239,303 (95% confidence interval [CI], 180,322–298,284) children visited the ED for FAs, demonstrating a significant rate increase during the period (53.08, $P < 0.001$). Logistic regression showed that the odds of ED visits for FAs were significantly associated with Medicaid/State Children's Health Insurance Program insurance (OR, 1.65 [95% CI, 1.01–2.69], $P = 0.04$), adolescents (OR, 1.92 [95% CI, 1.10–3.35], $P = 0.02$), and boys (OR, 1.55 [95% CI, 1.03–2.35], $P = 0.04$). Treatment with epinephrine for anaphylaxis diagnoses occurred in 57.4% of visits (95% CI, 42.3%–66.8%).

Conclusions: Medicaid/State Children's Health Insurance Program–insured pediatric patients had higher odds of visiting ED for recognized FAs and nonspecific allergic reactions and higher odds of receiving epinephrine than privately insured children.

Key Words: food allergies, Medicaid, SCHIP, treatment guidelines

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Food allergies (FAs) are estimated to be prevalent among 4% to 8% of children,^{1–5} and emergency department (ED) visits may account for up to 20% of the total FA economic burden in the United States, second largest cost after office visits (52.5%).⁶ In 2010, the National Institute of Allergy and Infectious Diseases (NIAID) established definitions, diagnostic criteria, and management practices for FAs.^{7,8} Sharma et al⁹ summarized these guidelines for the pediatric ED provider to improve recognition and management of FAs. These pediatric ED-specific guidelines may improve subsequent diagnosis and treatment of FAs, but little is understood about utilization trends, medication treatment

patterns, and factors related to FA-related ED visits among pediatric patients in the United States from 2001 to 2010.

This study conceptualizes the factors associated with ED utilization as predisposing (age group, sex, race, Hispanic ethnicity), enabling (insurance status, metropolitan statistical area, US region), and need based (diagnoses).¹⁰ Differences in FA prevalence and health services utilization among subgroups of children exist in the United States, including higher FA prevalence among non-Hispanic blacks,^{2,4,5,11} higher general allergic disease among urban children,¹² and higher odds of ED visits for allergic reactions in the northeast, as compared with the south region of the United States.¹³

Many pediatric patients present with symptoms that cannot be definitively diagnosed as FAs in the ED. Although the incidence from the present data is unknown, research using ED chart review methods found that FAs may be the cause of approximately 47% of nonspecific allergic reaction based on the *International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM)* diagnosis codes, including “other anaphylactic reaction” (995.0) and “allergy, unspecified” (995.3).¹⁴ Our study analyzed these and other nonspecific diagnoses for which FAs were possible causes and made comparisons and contrasts of treatments to recognized FAs.

Finally, NIAID treatment recommendations for FAs were published in 2010; therefore, it was expected that, for the previous decade that this study analyzed, the concordance with peer-reviewed guidelines would be low. Suggesting widespread unfamiliarity with FA treatment protocols, a 2008 survey of primary care physicians revealed that fewer than 30% felt they had been adequately trained to care for children with FAs.¹⁵ Furthermore, for anaphylaxis, a potentially fatal allergic reaction for which epinephrine is the first-line treatment of choice in the ED,⁹ underutilization of epinephrine in the ED has been reported among pediatric patients.^{16–18}

METHODS

Sample data from the National Hospital Ambulatory Medical Care Survey (NHAMCS) from 2001 to 2010 included patients through age of 20 years who visited EDs in the United States.¹⁹ National Hospital Ambulatory Medical Care Survey is a 4-stage probability survey design that samples geographic areas, hospitals within these areas, EDs within hospitals, and patient visits within EDs. Because the estimates are based on a sample, rather than on the entire population of ED visits, they are subject to sampling variability. Weight variables provided by NHAMCS were used to calculate the nationally representative estimates for all analyses. The number of selected hospitals with eligible EDs during the study period ranged from 357 in 2008 to 428 in 2003. The participation rate of sampled hospitals during the study period varied from 89.4% in 2006 to 95.6% in 2001. Trained personnel completed a standardized patient record form for a systematic random sample of patient visits during a randomly assigned 4-week period. The number of forms collected in survey years varied from 29,975 in 2005 to 40,253 in 2003.

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The NHAMCS recorded up to 3 physician diagnoses per ED visit based on the *ICD-9-CM*. For FAs, we identified all visits with diagnosis codes of allergic contact dermatitis due to food (692.5); dermatitis due to food taken internally (693.1); anaphylactic shock attributable to adverse food reaction, specified for peanuts (995.61), fruits and vegetables (995.63), tree nuts and seeds (995.64), fish (995.65), food additives (995.66), milk products (995.67), eggs (995.68), and other specified foods (995.69); and other adverse food reactions, not otherwise specified (995.7).

Emergency department visits with nonspecific allergic reaction diagnoses were also identified using *ICD-9-CM*, including angioedema (277.6 and 995.1), allergic urticaria (708.0), allergic gastroenteritis or colitis (558.3), other anaphylactic reactions (995.0), and unspecified allergic reactions (995.3). Excluded from this diagnoses group were insect bite (919.4 and 919.5); toxic effect of venom, soap/detergents, and other nonmedicinals (989); and scabies (133.0). Unless associated with the presence of a diagnosis described previously, we excluded patient visits with diagnoses of allergic rhinitis (477), allergic conjunctivitis (374.14), edema (782.3), rash and other nonspecific skin eruption (782.1), and atopic dermatitis (691.8).

Medications prescribed or administered at the ED visit were documented in the survey. Up to 6 medications per visit were recorded in 2001 and 2002. Starting in 2003, the maximum number of recorded medications per visit was increased to eight. This study categorized medication treatment of FAs and nonspecific allergic reactions in a hierarchical manner. That is, if the patient was prescribed or administered epinephrine, then the visit was categorized as “epinephrine.” If the visit record included antihistamine, but not epinephrine, then the visit was categorized as “antihistamine.” If the visit record included corticosteroid, but neither epinephrine nor antihistamine, then the patient visit was categorized as “corticosteroid.” All other ED visits where medications were prescribed or administered were categorized as “other medications.”

To analyze diagnosis frequency, SAS (SAS Institute, Cary, NC) PROC SURVEYFREQ enabled calculation of weighted frequencies with standard deviations and 95% confidence intervals (lower and upper). We also calculated rates of FAs per 100,000 US noninstitutional population with the US Census Bureau age-specific national population estimates for the years 2001 to 2010 used as denominators.²⁰ To examine temporal trends in FAs, the

TABLE 1. Characteristics Associated With ED Visits for FA and Nonspecific Allergic Reaction-Related Diagnoses Among Infants, Children, and Adolescents

	Recognized FAs (n = 239,303)				Nonspecific Allergic Reactions (n = 2,767,538)				χ^2
	Weighted Frequency	95% CI for Weighted Frequency	Proportion, %	% SE	Weighted Frequency	95% CI for Weighted Frequency	Proportion, %	% SE	
Insurance									
Private	125,507	(87,919–163,095)	52.4	6.3	1,225,414	(1,083,117–1,367,711)	44.3	2.3	
Medicaid or SCHIP	65,960	(38,203–93,717)	27.6	5.6	1,049,079	(908,759–1,189,399)	37.9	2.3	
Self-pay	26,747	(8024–45,470)	11.2	3.9	236,058	(166,171–305,945)	8.5	1.3	
Pay other*	21,089	(7,503–34,675)	8.8	2.9	256,987	(175,213–338,761)	9.3	1.5	
Age, y									†
<2	70,560	(40,169–100,951)	29.5	5.9	431,651	(335,607–527,695)	15.6	1.7	
2–12	109,032	(75,377–142,687)	45.6	6.3	1,532,011	(1,367,915–1,696,107)	55.4	2.3	
13–20	59,711	(33,310–86,112)	25.0	5.4	803,876	(689,456–918,296)	29.0	2.0	
Sex									
Female	146,137	(110,812–181,462)	61.1	6.2	1,384,263	(1,229,010–1,539,516)	50.0	2.3	
Male	93,166	(59,960–126,372)	38.9	6.2	1,383,275	(1,235,261–1,531,289)	50.0	2.3	
Race									
White	175,661	(136,805–214,517)	73.4	5.3	1,887,923	(1,727,672–2,048,174)	68.2	2.2	
Black	53,489	(30,335–76,643)	22.4	4.9	706,193	(585,256–827,130)	25.5	2.1	
Other	10,153	(0–22,231)	4.2	2.5	173,422	(107,121–239,723)	6.3	1.2	
Ethnicity									
Hispanic	22,007	(6643–37,371)	9.2	3.3	213,404	(143,103–283,705)	7.7	1.3	
Non-Hispanic	217,296	(180,234–254,358)	90.8	3.3	2,554,134	(2,388,460–2,719,808)	92.3	1.3	
Metropolitan statistical area									
MSA	205,771	(171,367–240,175)	86.0	4.9	2,282,215	(2,120,546–2,443,884)	82.5	1.9	
Non-MSA	33,532	(8962–58,102)	14.0	4.9	485,323	(376,477–594,169)	17.5	1.9	
US Region									‡
Northeast	53,597	(29,686–77,508)	22.4	5.0	568,237	(473,196–663,278)	20.5	1.7	
Midwest	32,526	(15,896–49,156)	13.6	3.6	534,368	(437,284–631,452)	19.3	1.8	
South	77,158	(45,272–109,044)	32.2	6.0	1,257,085	(1,098,389–1,415,781)	45.4	2.4	
West	76,022	(43,032–109,012)	31.8	6.1	407,848	(309,354–506,342)	14.7	1.7	

*Includes other, no charge/charity, worker's compensation, Medicare, and don't know responses.

†<0.05.

‡<0.01.

point estimate of ED visits was used as annual ED visit rate. A χ^2 test for trend was used to determine whether there was a significant linear trend in recognized FAs.

Three multivariate logistic regression models were constructed. SAS PROC SURVEYLOGISTIC was used to account for complex survey sampling design. The first logistic regression model analyzed the association of factors on recognized FAs, the second modeled nonspecific allergic reaction diagnoses, and the third model combined both recognized FAs and nonspecific allergic reaction diagnoses. Estimation assumed independence of individual patients for each ED visit.

Predisposing factors predicting health services utilization used in the logistic regression models included age group, sex, race, and Hispanic ethnicity. Age groups were categorized as infants (<2 y), children (2–12 y), and adolescents (13–20 y). The race variables were categorized as white, black, and other (Asian, Native Hawaiian/other Pacific Islander, American Indian/Alaska Native, or more than 1 race reported). Health service utilization enabling factors included insurance status, metropolitan statistical area, and US region. Insurance variables were categorized as private, Medicaid/State Children's Health Insurance Program (SCHIP), self-pay, and pay other. The "pay other" insurance variable included NHAMCS visits coded as other, no charge/charity, worker's compensation, and Medicare and "don't know" responses. Metropolitan statistical areas were based on location of the surveyed hospital using the definition of the Bureau of the Census and the US Office of Management and Budget.²¹ Finally, US region variables included northeast, south, midwest, and west, as defined by NHAMCS.¹⁹

Anaphylaxis for FAs and nonspecific allergic reactions were defined using ICD-9-CM codes, including other anaphylactic reactions (995.0) and anaphylactic shock attributable to adverse food reaction (995.61–995.69).

RESULTS

Accounting for the sampling weights and complex sample design, there were an estimated 239,303 (95% confidence interval [CI], 180,322–298,284) ED visits by patients younger than 21 years for FAs in the United States from 2001 to 2010 or approximately 24,000 ED visits per year. Table 1 shows the characteristics associated with ED visits for FAs among patients younger than 21 years. The mean age of the survey sample diagnosed with FAs was 7.05 years (95% CI, 5.3–8.8), ranging from 0 to 20 years. Emergency department visits for FAs accounted for 0.07% (95% CI, 0.05%–0.09%) of all child ED visits during the 10-year period.

There were an estimated 2,767,538 (95% CI, 2,333,260–3,201,816) nonspecific allergic reactions in the United States from

2001 to 2010. Table 1 also shows the characteristics of patients younger than 21 years with these diagnoses. Survey design of corrected χ^2 comparisons of the characteristics of recognized FAs and nonspecific allergic reactions revealed statistically significant differences in proportions between age groups ($\chi^2 = 1.15$, $P = 0.02$) and US regions ($\chi^2 = 1.07$, $P = 0.003$).

Among recognized FAs, there was a statistically significant increasing linear trend in ED visits during this period ($\chi^2 = 53.08$, $P < 0.001$). Figure 1 illustrates the estimated trend in FA ED visits from 2001 to 2010. Estimated rates for FA ED visits per 100,000 children in the United States range from 10.71 (95% CI, 0–21.98) in 2001 to 61.86 (95% CI, 24.10–99.61) in 2010.

Table 2 shows the estimated diagnoses for ED visits for FAs by children younger than 21 years in descending order of frequency. Among the FA visits, dermatitis due to food taken internally (ICD-9, 693.1) was the most common diagnosis, with an estimated 195,594 ED visits (95% CI, 129,452–261,828) or 81.1% of the FA ED visits. In addition, asthma comorbidities, commonly associated with FAs,²² were coded in only an estimated 1961 visits (95% CI, 0–5855) or less than 1% of the child FA ED visits in the period. The mean duration time for ED-recognized FAs was 320 minutes (95% CI, 104–536), or 5 hours and 20 minutes, and a standard deviation of 109 minutes (1 hour, 48 minutes). None of the ED visits for FAs examined in this study resulted in death.

For every recognized FA diagnosis in the ED, an estimated 11 nonspecific allergic reactions were coded. Table 3 demonstrates the weighted frequency of nonspecific allergic reaction diagnoses and their estimated relative proportion. "Allergy, unspecified, not elsewhere classified" diagnoses were coded at an estimated 2,186,589 visits (95% CI, 1,918,535–2,454,643) or 77.3% (95% CI, 67.9%–86.8%) of the nonspecific allergic reactions in the ED for the period.

The results of the multivariate logistic regression models identifying the factors associated with ED visits are shown in Table 4. For FAs, pediatric patients insured by Medicaid/SCHIP were 1.65 times more likely (95% CI, 1.01–2.69) to present to the ED ($P = 0.04$), as compared with those covered by private insurance. Compared with female patients, male patients had 1.55 times the odds (95% CI, 1.03–2.35) of presenting to the ED for FAs ($P = 0.04$). Adolescents had 1.92 times the odds (95% CI, 1.10–3.35) of visiting the ED, as compared with infants ($P = 0.02$). Race, Hispanic ethnicity, metropolitan statistical area, and US region were not statistically associated with FA ED visits among this national pediatric patient sample.

Also in Table 4, logistic regression models were constructed for nonspecific allergic reaction diagnoses only and combined

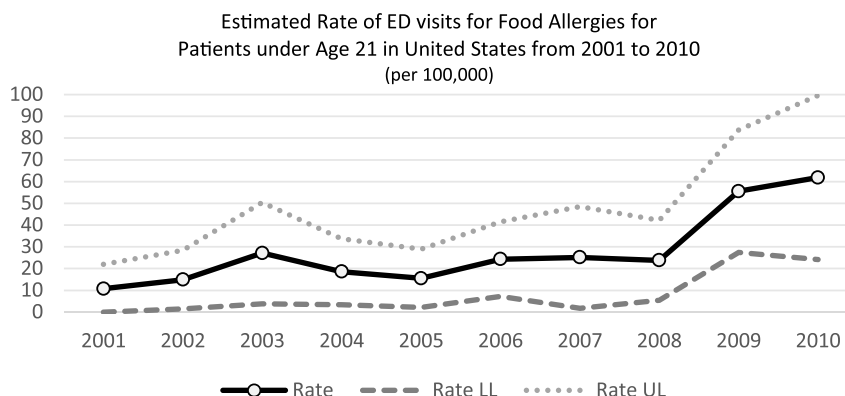


FIGURE 1. Estimated rate of ED visits for FAs for patients younger than 21 years in United States from 2001 to 2010 (per 100,000).

TABLE 2. Proportion of Recognized FA Diagnoses Among Children Presenting to the ED, Including Those Multiple FA Diagnoses (N = 241,245)

Diagnosis	ICD-9	Weighted Frequency	95% CI for Weighted Frequency	Proportion, %
Dermatitis due to food taken internally	693.1	195,594	(129,452–261,828)	81.1
Other adverse food reaction, not otherwise specified	995.7	32,681	(16,396–50,446)	13.5
Anaphylactic shock attributable to adverse food reaction, specified for peanuts, fruits and vegetables, tree nuts and seeds, fish, food additives, milk products, eggs, or other specified food	995.61–995.69	11,497	(4971–18,023)	4.8
Allergic contact dermatitis due to food	692.5	1473	(0–1473)	0.6

Excluded from analysis: “insect bite, NEC” (919.4 and 919.5), “toxic effect of venom, soap/detergents, and other nonmedicinals” (989), and “scabies” (133.0) coded as first, second, or third diagnosis. Unless there is presence of abovementioned diagnoses, we excluded patients with allergic reaction–related ICD-9 codes of “allergic rhinitis” (477) and “allergic conjunctivitis” (374.14), “edema” (782.3), “rash and other nonspecific skin eruption” (782.1), and “atopic dermatitis” (691.8).

with recognized FAs. In the nonspecific allergic reaction model, pediatric patients insured by Medicaid/SCHIP were 1.18 times more likely (95% CI, 1.00–1.39) ($P = 0.04$), self-pay were 1.34 times more likely (95% CI, 1.00–1.39) ($P = 0.03$), and the “pay other” insurance category group were 1.38 times more likely (95% CI, 1.00–1.39) to visit the ED for nonspecific allergic reactions ($P = 0.02$), as compared with those with private insurance. Children (aged 2–12 y) were 36% less likely (95% CI, 0.64–0.79) of visiting the ED for nonspecific allergic reactions, as compared with infants ($P < 0.001$). Nonspecific allergic reaction ED visits occurring in hospitals in the west US had 1.29 times higher odds (95% CI, 1.02–1.63) of visits to the ED for diagnoses, compared with those in the northeast US region.

In the model with the dependent variables of the first 2 models combined, shown in Table 4, children insured by Medicaid/SCHIP had 18% higher odds (95% CI, 1.01–3.67) of presenting to the ED ($P = 0.04$). In addition, children (aged 2–12 y) had 29% lower odds (95% CI, 0.59–0.85) of visiting the ED with these diagnoses, as compared with infants ($P < 0.001$). Emergency department visits occurring in hospitals in the mid-west US had 1.27 times higher odds (95% CI, 1.04–1.56), compared with those in the northeast US region.

Table 5 shows proportions of medication administered or prescribed for recognized FAs and nonspecific allergic reaction diagnoses. The treatment proportions of these groups were significantly statistically different, according to a χ^2 test of

proportions ($\chi^2 = 10.08$, $P = 0.02$). For example, epinephrine was administered or prescribed for nonspecific allergic reactions only 12.8% of the time (95% CI, 10.6–14.7), significantly less often than the 27.4% for recognized FAs (95% CI, 19.2–33.5%). The “other medications” category included bronchodilators for respiratory symptoms, diuretics for edema, and antibiotics (eg, augmentin and cephalexin).

Table 6 shows the multivariate logistic regression model analyzing the association of covariates discussed previously to epinephrine treatment as the dependent variable among FA and nonspecific allergic reaction visits. Medicaid/SCHIP-insured pediatric patients had almost twice the odds of being administered or prescribed epinephrine (OR, 1.99; 95% CI, 1.27–3.12; $P = 0.003$).

Anaphylaxis was coded in the ED for an estimated 26,781 (95% CI, 15,109–38,453) visits or only 0.9% (95% CI, 0.7%–1.4%) of all the FA-diagnosed and nonspecific allergic reaction–diagnosed visits. For the anaphylaxis-diagnosed visits only, epinephrine was administered or prescribed 57.4% (95% CI, 42.2%–66.8%) of the time.

DISCUSSION

In this nationally representative estimation, the rate of ED visits for FAs per 100,000 US children increased as much as 6-fold from 2001 to 2010. This is consistent with the increase in prevalence of FAs among pediatric patients in the 2000s.^{1,5} This

TABLE 3. Proportion of Diagnoses Among Children Presenting to the ED for Nonspecific Allergic Reactions, Including Those Multiple Allergic Reaction Diagnoses (N = 2,827,161)

Diagnosis	ICD-9	Weighted Frequency	95% CI for Weighted Frequency	Proportion, %
Allergy, unspecified, not elsewhere classified	995.3	2,186,589	(1,918,535–2,454,643)	77.3
Allergic urticaria	708.0	403,529	(300,636–507,159)	14.3
Angioneurotic edema, NOS	995.1	164,205	(93,707–234,703)	5.8
Other anaphylactic reaction	995.0	32,086	(19,553–46,511)	1.1
Allergic gastroenteritis and colitis	558.3	28,786	(9708–47,864)	1.0
Angioedema	277.6	7993	(0–45,057)	0.3
Laryngospasm	478.75	2965	(0–40,639)	0.1
Bronchospasm	519.11	1008	(0–13,816)	0.04

Excluded from analysis: FAs listed in Table X, “insect bite, NEC” (919.4 and 919.5), “toxic effect of venom, soap/detergents, and other nonmedicinals” (989), and “scabies” (133.0) coded as first, second, or third diagnosis. Unless there is presence of abovementioned diagnosis, we excluded patients with allergic reaction–related ICD-9 codes of “allergic rhinitis” (477) and “allergic conjunctivitis” (374.14), “edema” (782.3), “rash and other nonspecific skin eruption” (782.1), and “atopic dermatitis” (691.8).

TABLE 4. Logistic Regression Models Adjusted for Complex Survey Design for Factors Associated With ED Visits for FAs, Nonspecific Allergic Reactions, and Both Groups Combined Among Pediatric Patients Younger Than 21 Years in the United States From 2001 to 2010

Characteristic	FAs				Nonspecific Allergic Reactions				FAs and Unspecified Allergic Reactions			
	Coefficient	OR	95% CI	P	Coefficient	OR	95% CI	P	Coefficient	OR	95% CI	P
Insurance												
Private	—	1.00	—	—	—	1.00	—	—	—	1.00	—	—
Medicaid or SCHIP	0.25	1.65	(1.01–2.69)	0.04	0.08	1.18	(1.00–1.39)	0.04	0.08	1.18	(1.01–1.37)	0.04
Self-pay	0.08	1.17	(0.59–2.31)	0.65	0.15	1.34	(1.03–1.74)	0.03	0.12	1.27	(0.99–1.62)	0.06
Pay other	−0.04	0.92	(0.50–1.72)	0.80	0.16	1.38	(1.05–1.80)	0.02	0.04	1.08	(0.82–1.43)	0.57
Age groups, y												
<2	—	1.00	—	—	—	1.00	—	—	—	1.00	—	—
2–12	0.19	1.47	(0.90–2.42)	0.13	−0.22	0.64	(0.52–0.79)	<0.001	−0.17	0.71	(0.59–0.85)	<0.001
13–20	0.33	1.92	(1.10–3.35)	0.02	−0.05	0.91	(0.73–1.14)	0.41	0.004	1.01	(0.82–1.24)	0.94
Sex												
Female	—	1.00	—	—	—	1.00	—	—	—	1.00	—	—
Male	0.22	1.55	(1.03–2.35)	0.04	<0.001	1.00	(0.87–1.15)	1.00	0.02	1.05	(0.92–1.20)	0.49
Race												
White	—	1.00	—	—	—	1.00	—	—	—	1.00	—	—
Black	−0.12	0.78	(0.49–1.26)	0.32	−0.02	0.97	(0.81–1.15)	0.70	−0.02	0.96	(0.81–1.12)	0.58
Other	0.07	1.15	(0.45–2.91)	0.76	−0.17	0.72	(0.53–0.97)	0.03	<0.001	0.76	(0.57–1.01)	0.06
Ethnicity												
Hispanic	−0.14	0.75	(0.39–1.46)	0.41	0.02	1.03	(0.78–1.37)	0.81	<0.01	1.00	(0.77–1.29)	1.00
Non-Hispanic	—	1.00	—	—	—	1.00	—	—	—	1.00	—	—
Metropolitan statistical area												
Non-MSA	—	1.00	—	—	—	1.00	—	—	—	1.00	—	—
MSA	0.03	1.07	(0.55–2.09)	0.84	0.11	1.09	(0.89–1.34)	0.40	−0.04	0.92	(0.76–1.13)	0.43
US region												
Northeast	—	—	—	—	—	1.00	—	—	—	1.00	—	—
Midwest	−0.12	0.78	(0.45–1.38)	0.15	0.11	1.24	(0.99–1.54)	0.05	0.12	1.27	(1.04–1.56)	0.02
South	0.20	1.50	(0.88–2.57)	0.14	−0.01	0.98	(0.81–1.18)	0.82	<0.001	1.02	(0.85–1.22)	0.85
West	0.22	1.57	(0.85–2.91)	0.40	0.13	1.29	(1.02–1.63)	0.03	0.09	1.20	(0.97–1.49)	0.10

increasing trend in FAs recognized and coded in the ED is concerning due to the potentially high incidence of fatalities that occur from unintentional exposures to known allergic reaction-causing foods.^{17,18,23}

This is the first study to identify insurance status as a related factor to ED utilization for FAs and nonspecific allergic reactions. In each of the multivariate logistic regression models, Medicaid/SCHIP-insured children had modestly higher odds of visiting the ED, compared with privately insured children. Despite the

perpetuated myth that “Medicaid is, in effect, designed to increase emergency-room usage,”²⁴ increased ED utilization for Medicaid-covered children does not exist when compared with those with private insurance.²⁵ However, an increase in ED utilization has been previously reported with asthma, another treatable but potentially fatal chronic disease.^{26–28} Although the relationship between Medicaid and health care utilization is complex, ED utilization among the Medicaid/SCHIP-insured children for FAs and nonspecific allergic reactions may be due to challenges in accessing primary care services, especially after hours.²⁹

It is not surprising that adolescents, who have higher levels of responsibility regarding food selection than younger children,⁸ have increased odds of ED visits in the United States for recognized FAs. Adolescents may defy the recommendation to carry 2 autoinjectors at all times⁷ and engage in risky behaviors in social situations³⁰ to avoid feelings of social isolation from their peers. These psychosocial factors obstruct effective FA management among adolescents and present an increasing challenge for pediatric ED providers.³¹ However, the emergence of online patient support groups for adolescents at risk for anaphylaxis has shown to be effective in strengthening coping skills, self-esteem, and FA management compliance.^{32,33}

Diagnosis of immune-mediated FAs in the ED is complex and rarely definitive.⁹ In this study, only 8.7% (95% CI, 5.7%–9.5%) of all allergic reactions examined were recognized as

TABLE 5. Medication Categories Prescribed or Administered at ED Visit Among FAs and Nonspecific Allergic Reactions in the United States From 2001 to 2010

	FAs (n = 239,303)		Nonspecific Allergic Reactions (n = 2,767,538)	
	%	95% CI	%	95% CI
Epinephrine	27.4	(19.2–33.5)	12.8	(10.6–14.7)
Antihistamine	49.3	(40.6–55.8)	63.2	(61.4–64.8)
Corticosteroid	4.2	(0.5–7.0)	9.9	(7.6–12.0)
Other medications	19.1	(8.7–26.7)	14.1	(12.6–15.4)

TABLE 6. Logistic Regression Model Adjusted for Complex Survey Design for Factors Associated With Prescription or Administration of Epinephrine for FAs and Nonspecific Allergic Reactions Among Pediatric Patients Younger Than 21 Years From 2001 to 2010 (N = 381,141)

Characteristic	Epinephrine Administered or Prescribed			
	Coefficient	OR	95% CI	P
Insurance				
Private	—	1.00	— —	—
Medicaid or SCHIP	0.3432	1.987	(1.27–3.12)	0.003
Self-pay	0.1701	1.405	(0.69–2.87)	0.35
Pay other	0.3089	1.855	(0.81–4.25)	0.14
Age groups, y				
<2	—	1.00	— —	—
2–12	0.4428	2.424	(1.21–4.87)	0.01
13–20	0.1328	1.304	(0.84–2.02)	0.24
Sex				
Female	—	1.00	— —	—
Male	−0.1261	0.777	(0.52–1.17)	0.23
Race				
White	—	1.00	— —	—
Black	−0.0631	0.881	(0.56–1.40)	0.59
Other	−0.00463	0.991	(0.42–2.35)	0.98
Ethnicity				
Non-Hispanic	—	1.00	— —	—
Hispanic	−0.2392	0.62	(0.30–1.29)	0.20
Metropolitan statistical area				
Non-MSA	—	1.00	— —	—
MSA	−0.049	0.952	(0.53–1.70)	0.87
US Region				
Northeast	—	1.00	— —	—
Midwest	−0.4819	0.381	(0.21–0.70)	0.002
South	−0.2095	0.658	(0.37–1.17)	0.15
West	−0.3371	0.51	(0.27–0.97)	0.04

FAs. This is a smaller proportion than other studies, such as those of Braganza,¹⁶ Noble et al,³⁴ and Rudders et al¹⁷ where 14.7%, 21.9%, and 44%, respectively, of the patients knew the precipitating food of the allergic reaction. However, comparisons are difficult due to the ambiguity in FA presentation in the ED.^{7,8} Furthermore, our FA estimate may be high as some FA diagnoses may

have actually been non-immune-mediated adverse food reactions, such as food intolerances.

Nonetheless, it is likely that food was the cause of many of the nonspecific allergic reaction diagnoses included in this study. In a separate study, a medical chart review study of nonspecific allergic reaction diagnoses codes (995.3) found that approximately half of them were, in fact, caused by FAs.¹⁴ Table 7 outlines the studies regarding nonspecific allergic reaction diagnoses where FAs may be the possible cause.^{35–38} On the basis of these estimates, approximately 50,000 pediatric ED visits for FAs may be undiagnosed each year. To improve recognition of FAs, Sharma et al⁹ describe the essentials of medical history and physical examination in the ED, where detailed notes on the reaction, suspected food, and surrounding circumstances (eg, rule out poisoning) can uncover possible FA-causing agents.

Most ED visits included in this study could be classified as mild to moderate as less than 1% of the pediatric patients in this sample were diagnosed with anaphylaxis. However, under-reporting of anaphylaxis is likely. This study did not analyze ED provider assessments of urgency due to lack of accepted method for evaluation of urgency,³⁹ nor did we apply any “appropriateness” evaluation because no validated criteria for inappropriate utilization using retrospective claims have been established.⁴⁰

Among included FA and nonspecific allergic reaction diagnoses, those pediatric patients covered by Medicaid/SCHIP had significantly higher odds of being prescribed or administered epinephrine. Another study by Huang et al⁴¹ found that children insured by Medicaid were less likely to receive epinephrine before arrival in the ED. These suggest an inequality among the Medicaid/SCHIP-insured children in the administration of epinephrine for FAs and nonspecific allergic reactions outside the ED. According to the Sampson et al,⁴² before discharge from an emergency facility, 3 steps should be followed for patients who experience anaphylaxis: (1) provide a self-injectable epinephrine prescription; (2) discuss educational material sources, such as Food Allergy Research & Education (www.foodallergy.org); and (3) advise a prompt follow-up evaluation.

At the ED, this study found that treatment of all anaphylaxis-related visits with epinephrine may be higher than previously reported. Our results showed that epinephrine was administered or prescribed for anaphylaxis 57.4% (95% CI, 42.2%–66.8%) of the time. This more closely follows guidelines than the epinephrine treatment rate found in previous studies by Rudders et al¹⁷ (50%), Brown et al⁴³ (27.4%), Hitti et al⁴⁴ (15.9%), and Ross et al⁴⁵ (19%). Although this proportion of epinephrine for anaphylaxis may seem low compared with treatment requirements,⁷ a limitation of the data in this study is that they do not account for epinephrine taken before arrival at the ED. For example, Rudders

TABLE 7. Nonspecific Allergic Reaction Diagnoses for Which FAs may be Possible Cause

Diagnosis	ICD-9	ICD-10	Weighted Frequency in This Study (95% CI)	Article(s)	Estimated Proportion of Possible FAs, %
Allergy, unspecified	995.3	T78.4	2,186,589 (1,918,535–2,454,643)	Clark et al ¹⁶	47
Other anaphylactic reaction	995.0	T78.2	32,086 (19,553–46,511)	Clark et al ¹⁶ & Sharma et al ⁹ & Braganza et al ¹⁸	47–56
Angioedema/angioneurotic edema	277.6/995.1	T78.3	172,198 (93,707–279,760)	Kulthanan et al ³⁵	41.7
Allergic urticaria	708.0	L50.0	403,529 (300,636–507,159)	Sehgal and Rege ³⁶	20
Allergic gastroenteritis and colitis	558.3	K52.2	28,786 (9,708–47,864)	Bischoff et al ³⁷ & Petitpierre et al ³⁸	14.4–37.5

et al¹⁷ found that approximately 23% of patients received at least 1 dose of epinephrine before arrival at the ED, usually from the patient's own device. Nonetheless, there may be capacity for improvement in treatment of anaphylaxis with epinephrine.

Moreover, although the sampling methodology provides reliable national estimates, inherent limitations of the data may limit the conclusions of this study. First, NHAMCS does include identifiers for individual patients, but this study assumed independence of individual patients for each ED visit. This may incorrectly provide more narrow CIs than appropriate. We believe this impact to be small as only 3.4% (95% CI, 2.0%–4.7%) of ED visits for FAs and nonspecific allergic reactions represented repeat ED visits within 72 hours. In addition, the NHAMCS survey sampling does not include urgent care centers and may underrepresent pediatric EDs, both of which would render our trend conclusions less accurate. Finally, NHAMCS collects race and ethnicity data through an unrelated observer and so may be misclassified or missing and later imputed, as in the case in 10.4% and 15.3% of race data and 12.8% to 23.8% of ethnicity data.

In the future, pediatric ED providers may face an ever increasing responsibility for educating patients and their parents on FA management. Because those covered by Medicaid/SCHIP were more likely to use the ED for FAs and nonspecific allergic reactions, the already increasing trend in ED visits for FAs may be intensified by Medicaid expansion under Patient Protection and Affordable Care Act of 2010.⁴⁶ To improve knowledge, recognition, and treatment of FAs, review of the NIAID guidelines⁸ and the Sharma et al⁹ summary of FAs for pediatric ED practitioners are recommended.

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