



Time Trends in Food Allergy Diagnoses, Epinephrine Orders, and Epinephrine Administrations in New York City Schools

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Objectives To assess time trends in food allergy diagnoses, epinephrine autoinjector (EAI) prescriptions, and EAI administrations in the school setting.

Study design In this retrospective study, deidentified student data from the New York City Department of Health and Mental Hygiene, which oversees >1 million students in 1800 schools, were provided to investigators. Data from school years 2007-2008 to 2012-2013 pertaining to diagnoses of food allergy, student-specific EAI orders, and EAI administrations among students in New York City were analyzed for trends over time, via the use of ORs and χ^2 calculation.

Results The prevalences of providing physician documentation of food allergy and EAI orders, and the incidence of EAI administrations, all increased approximately 3-fold over the years of the study. Of 337 EAI administrations, more than one-half used stock EAI, and three-quarters were for students without a student-specific order preceding the incident.

Conclusions The rise in food allergy diagnoses, EAI prescriptions, and EAI administrations suggest either a true increase in allergic disease, increased reporting, and/or, in the case of EAI administrations, increased appropriate use. As the majority of EAI administrations used stock supply, availability of nonstudent-specific stock EAI appears vital to management of anaphylaxis in schools. Collaboration between physicians, families, and schools is needed to identify students at risk for severe allergic reactions and to ensure preparedness and availability of EAI in the event of anaphylaxis. (*J Pediatr* 2017;190:93-9).

Food allergy and anaphylaxis are startlingly common among children in the US. Food allergy is estimated to affect up to 8% of children, more than one-third of whom report having severe reactions.¹ Furthermore, the prevalences of both food allergy and anaphylaxis appear to be increasing.²⁻⁷ The leading cause of anaphylaxis in children is food allergy; other common causes include insect venom hypersensitivity and medication allergy.⁷⁻¹² Anaphylaxis can manifest with difficulty breathing, throat swelling, and decrease in blood pressure, and can, although quite rarely, be fatal.¹³ The potentially life-saving treatment for anaphylaxis is the timely administration of epinephrine.^{14,15} To address this risk for anaphylaxis, standard management for food allergy (and other conditions associated with risk of anaphylaxis) is strict avoidance of the trigger and preparedness at all times with an epinephrine autoinjector (EAI) in case a severe reaction occurs.

With children spending most of their days in school, schools must have a system for identifying at-risk students and ensuring availability of EAI in the event of a severe allergic reaction. Fatal and near-fatal anaphylactic reactions, although rare, do occur in schools; most cases have been associated with delayed administration of epinephrine.^{10,16-19} EAI administration in schools is of particular relevance due to school policy changes regarding EAI stocking and administration, across the country and within New York City (NYC). Historically, EAI could only be administered in school if a student-specific order was on file. The School Access to Emergency Epinephrine Act, enacted in 2013, incentivized most states across the US to mandate stocking of nonstudent-specific epinephrine in schools (<https://www.foodallergy.org/advocacy/epinephrine/map>). In schools under supervision of the NYC Department of Health and Mental Hygiene (DOHMH), stocking of nonstudent-specific EAI has been mandatory since the school year 2005-2006. In addition to continued training of staff in proximity to at-risk students, the NYC DOHMH has increasingly over the past several years offered training in recognition and treatment of anaphylaxis to all school staff.

There are few studies addressing epidemiology of food allergy and anaphylaxis in US schools²⁰⁻²² and fewer providing insight into how this is changing over time.^{21,23} In this report, we describe trends in reporting of physician-diagnosed

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DOHMH Department of Health and Mental Hygiene
EAI Epinephrine autoinjector
EHR Electronic health records
MAF Medication administration form
NYC New York City

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food allergy, student-specific EAI, and EAI use in schools over a 6-year period in the NYC public school system.

Methods

For this retrospective study, NYC DOHMH provided investigators with collated and deidentified student data pertaining to food allergy diagnoses and student-specific physician orders for EAI for school years 2007-2008 to 2012-2013 and EAI administrations for school years 2008-2009 to 2012-2013. These data were extracted from the city-wide electronic health records (EHRs) of the >1 million students in 1800 schools overseen by the NYC DOHMH. Each student's medical diagnoses, prescriptions to be used in and out of school, and administrations of medication in school are documented in the student EHR; further details as to how these are recorded are provided under the subheadings to follow. Schools under supervision of the NYC DOHMH are exclusively urban, with students diverse in race, ethnicity, and socioeconomic status. For this study, grades kindergarten to fifth were considered elementary school, grades 6-8 middle school, and 9-12 high school. This study was approved by the institutional review boards of the Icahn School of Medicine at Mount Sinai and the NYC DOHMH.

Each year, students in the NYC public school system are asked to provide the schools with physician documentation of all medical conditions on a health examination form as well as physician orders for the student's medications on a medication administration form (MAF). Both are completed by the child's healthcare provider and provided to the school health office by the parent. Medical diagnoses (based on the health examination form, MAF, or other physician documentation) as well as physician orders from the MAF, are entered into the student's EHR.

In schools under supervision of the NYC DOHMH, all administrations of medications, including EAI, require mandatory recording in the city-wide EHR. This recording is completed by a school nurse within 24-48 hours of administration of the medication. The indication and the date and time of administration are recorded. For EAI, source of the medication (stock or student-specific) is documented as well. Two 2-packs of EAIs (one junior and one regular) were provided to each school during the study period and were replaced promptly if used. Funding for these EAI was provided for NYC DOHMH for the school years 2008-2009 and 2009-2010 and by Mylan through the EpiPen4Schools program for the subsequent 3 school years from 2010-2011 to 2012-2013.

Statistical Analyses

Data were analyzed with Microsoft Excel (2010; Microsoft, Redmond, Washington), RStudio (Version 0.99.896 RStudio, Inc, Boston, Massachusetts), and MedCalc Software (MedCalc, Ostend, Belgium) for general descriptive frequencies and for inferential trends using ORs with the mid-P calculation. Differences in proportions between school years were tested with χ^2 analysis.²⁴

Results

Demographics for all students in the NYC public school district are summarized in [Table I](#). The total number of students increased each school year from 1 037 560 in 2007-2008 to 1 116 346 in 2012-2013. There were more male than female students (51.3% male). Ethnic/racial distribution was as follows: the majority of students identified as Hispanic (39.4%), followed by black (30.2%), Asian (14.6%), white (14.3%), and other (1.5%). Regarding age distribution, 5.2% were in pre-kindergarten, 43.4% were in elementary school (kindergarten to fifth grade), 21% in middle school (sixth to eighth grade), and 30.3% in high school (ninth to 12th grade). Distribution of students' lunch pricing, which is based on economic status, was as follows: 59.3%, 6.6%, and 28.2% qualified for free, reduced, and full price, respectively; 6.6% had an unknown lunch pricing status.

Reporting of Physician-Diagnosed Food Allergy

The portion of total students in the NYC public school system who provided documentation of physician-diagnosed food allergy increased significantly over the years of the study from 0.39% (N = 4007) in 2007-2008 to 1.43% (N = 15 944) in 2012-2013 ([Figure](#), $P < .001$). As shown in [Table I](#), the prevalence of reported food allergy was greatest among students in elementary school, who were male, identified as white, and did not qualify for reduced-price or free lunch.

The portion of total students who provided MAFs for EAI increased significantly over the years of the study from 0.26% (N = 2647) in 2007-2008 to 0.74% (N = 8310) in 2012-2013 ([Figure](#)) ($P < .001$). As with food allergy diagnoses, prevalence of having MAF for EAI was greatest amongst younger students, males, those identifying as white, and those qualifying for full-price lunch ([Table I](#)).

Indications listed on EAI MAF are summarized in [Table II](#). The majority of physician orders for EAI were for either anaphylaxis due to food or food intolerance (79.3%). For orders with a specified culprit food, peanut (64.1%) was most commonly listed. Additional indications included anaphylaxis with unspecified cause (16.8%), asthma (1.6%), bee sting allergy (0.6%), urticaria and/or angioedema (0.6%), and anaphylaxis due to latex (0.4%). The remaining indications (each accounting for <0.1%) included additional atopic conditions and neurologic, hematologic, and immunologic disorders.

In total, over the 6 school years from 2007-2008 to 2012-2013, 48% of those with reported food allergy provided an MAF for EAI, and this percent trended down significantly from 50.1% in 2007-2008 to 46.5% in 2012-2013 ([Table III](#)) ($P < .001$).

In contrast to the aforementioned data regarding physician-diagnosed food allergy and physician orders for EAI, reporting of EAI administrations was not dependent on parent provision of physician-completed forms to the school health office. Instead, reporting of EAI administrations was completed by school health staff, who are required to document administrations in the city-wide EHR within 24-48 hours of administration.

Table I. Sociodemographics of all students and for students with a diagnosis of food allergy, students with MAF for epinephrine, and students for whom EAI was administered within the NYC public school system, for school years 2007-2008 to 2012-2013

Sociodemographics	All students N = 6 418 039* (%)	Food allergy diagnosis N = 56 037*			MAF on file N = 30 815*			EAI recipients† N = 335*		
		Percent of cases	Prevalence in group (%)	OR‡	Percent of case	Prevalence in group (%)	OR‡	Percent of case	Incidence in group (10 ⁻⁶)	OR‡
Sex§										
Male	51.3§	58.3	0.99	1.00	60	0.56	1.00	51.9	6.3	1.00
Female	48.7§	41.7	0.75	0.75	40	0.39	0.70	47.5	6.1	ns
School										
Preschool	5.2	2.9	0.48	0.36	4.5	11.2	15.2	—	—	—
Elementary	43.4	66.3	1.33	1.00	74.1	0.82	1.00	45.1	6.5	1.00
Middle	21.0	18.6	0.77	0.58	15.1	0.35	0.42	20.8	5.2	ns
High	30.3	12.2	0.35	0.26	6.2	0.10	0.12	19	3.3	ns
Race/ethnicity										
White	14.3	28.1	1.72	1.00	32.4	1.09	1.00	11.6	5.1	1.00
Hispanic	39.4	27.1	0.60	0.35	27.3	0.33	0.30	28.5	4.5	0.89
Black	30.2	26.8	0.77	0.45	23.2	0.37	0.34	43.6	9.1	1.80
Asian	14.6	16.1	0.96	0.55	15	0.49	0.44	12.2	5.2	ns
Other	1.5	1.9	1.12	0.65	2.1	0.69	0.63	2.0	8.4	0.17
Lunch pricing										
Free	59.3	43.5	0.64	1.00	39.6	0.32	1.00	57.3	6.0	1.00
Reduced	5.9	6.6	0.97	1.52	6.0	0.48	1.51	7.1	7.8	ns
Full price	28.2	46.8	1.45	2.28	51	0.87	2.72	30.9	6.5	ns
Unknown	6.6	3.0	0.40	0.63	3.4	0.25	0.76	4.7	6.3	ns

ns, not significant.

Significance was defined as $P < .05$.

*N represents number of student-year observations, totaled over the years of the study.

†For EAI recipients, data were not available for school year 2007-2008. There was no demographic information for 2 recipients of epinephrine. Grade was not specified for 15.1% ($n = 51$) epinephrine administrations. Race/ethnicity was not specified for 2.0% ($n = 7$) epinephrine administrations.‡All presented ORs are associated with $P < .001$, determined with mid-P calculation.

§There were 4 students in 2010-2011 and 5 in 2012-2013 whose sex was uncategorized.

There were a total of 337 EAI administrations over 5 school years: 38 in 2008-2009, 35 in 2009-2010, 65 in 2010-2011, 86 in 2011-2012, and 113 in 2012-2013 (Table III). The increase from 2008-2009 to 2012-2013 was statistically significant ($P < .001$). Yearly incidence of EAI administrations trended up on average 1.3 administrations per year, from 3.7 per 100 000 students in 2008-2009 to 10.1 per 100 000 students in 2012-2013 (Figure).

Sociodemographics of students requiring EAI administration from school years 2008-2009 to 2012-2013 are provided in Table I. Mean age of students receiving EAI administration was 10.4 years (IQR 7.1-13.4). Yearly incidence was greater among students identifying as black and did not appear to be influenced by age, sex, or socioeconomic status.

Of the 337 EAI administrations from 2008-2009 to 2012-2013, 42.4% were given for anaphylaxis due to food and 10.4% were for anaphylaxis of unspecified cause (Table II). For 47.2% of administrations, the indication was not specified. Of those administrations with a specified inciting food ($N = 131$), the most commonly reported food was peanut (83.9%). Additional reported inciting foods are listed in Table II.

In total, over the 5 years from 2008-2009 to 2012-2013, 21.4% of students treated with an EAI provided their school with an MAF for EAI before the episode, and another 28.5% provided an MAF following the EAI administration event (Table III). More than one-half of students requiring EAI did not provide an MAF before or following the incident; this

portion decreased over 5 years from 63% in 2008-2009 to 45% in 2012-2013. EAI recipients identifying as white had increased odds of providing an MAF before administration compared with EAI recipients identifying as black (OR 2.6, 95% CI 1.2-5.7, $P = .016$) or Asian (OR 3.3; 95% CI 1.1-9.7, $P = .033$). Of those administrations in which lunch status was known ($N = 321$), provision of MAF before administration was not significantly different among recipients with full-price lunch compared with those without full-price lunch (OR 1.0, 95% CI 0.58-1.8, $P = .93$).

Although most medications may only be administered in school using student-specific medication with a physician order on file, recent policy changes have allowed for the stocking and administration of nonstudent-specific EAI. Of the 337 EAI administrations over 5 school years, during which nonstudent epinephrine was stocked in all NYC schools under supervision of NYC DOHMH, stock EAI was used for more than one-half (51.9%; $N = 175$) of the administrations (Table III). The portion of administrations for which the source was reported as student-specific was low across all years (22.3%) but increased each school year from 13% in 2008-2009 to 26% in 2012-2013. The source of EAI was not specified for 25.8% of administrations during these 5 school years. Among stock EAI recipients ($N = 175$), 92.6% ($N = 162$) were without an EAI MAF on file. Of stock recipients given EAI for a reported food allergic reaction ($N = 65$), 51% were without documented history of food allergy; it is not clear what portion of these

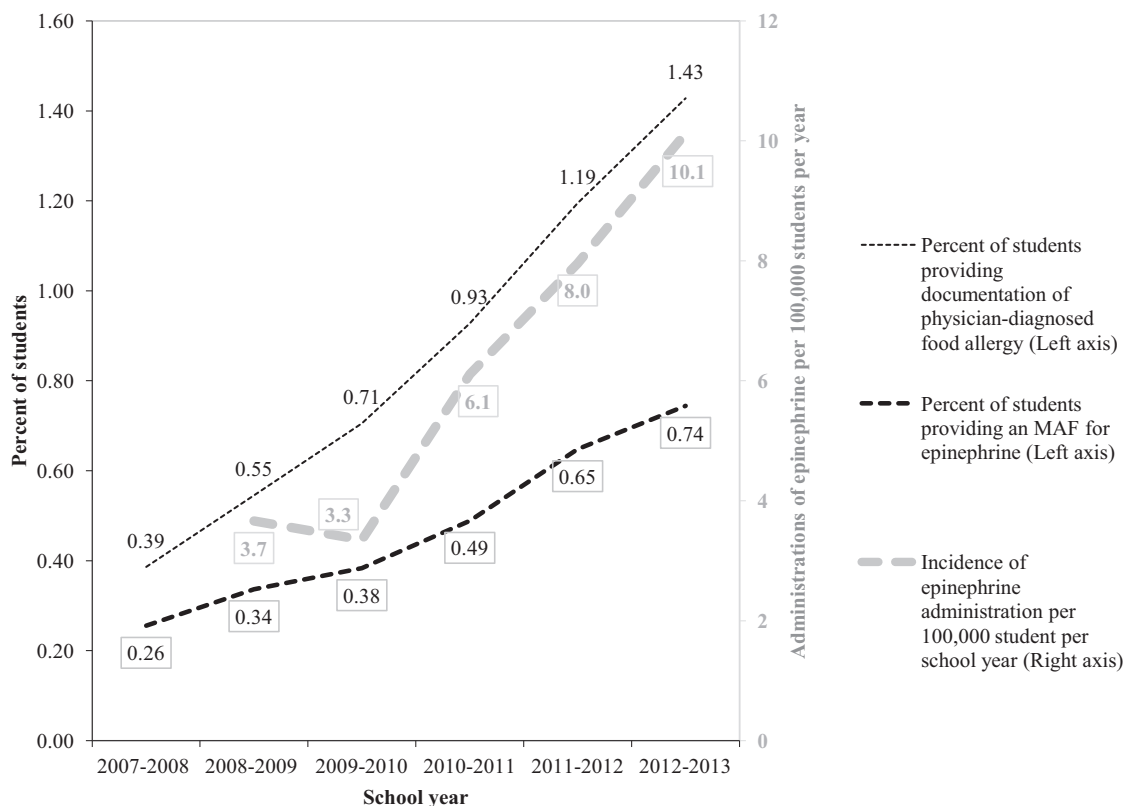


Figure. Trends in reporting of physician-diagnosed food allergy, provision of an MAF with physician order for epinephrine, and administrations of epinephrine* for students in the NYC public school system from school years 2007-2008 to 2012-2013. *Data on administrations were not available for school year 2007-2008.

were first-time reactors, vs students who failed to provide documentation despite being aware of their food allergy. For EAI administrations in which the source was known ($N = 307$), the portion of students receiving stock (rather than student-specific) EAI was not significantly different for white recipients compared with nonwhite ($P = .37$); nor for students with full-price lunch compared with students with reduced or free lunch pricing ($P = .35$).

Discussion

In this study, we present trends in prevalence and sociodemographics of food allergy and anaphylaxis among school children in NYC over 6 school years from 2007-2008 to 2012-2013, as estimated from documented physician-diagnosed food allergy, physician orders for EAI, and administrations of EAI. Findings from this study suggest that allergy and anaphylaxis are on the rise in schools, many at-risk students are without documentation of allergy, and most at-risk children rely on stock supply of nonstudent-specific EAI for treatment of anaphylaxis. Two previously published studies on EAI administrations in schools are limited to 1-2 school years.^{20,22} Two additional US school-based studies report incidence of epinephrine administration or incidence of

anaphylaxis over a number of school years.^{21,23} The present study addressed time trends in reported food allergy diagnoses, EAI orders, and EAI administrations in a US school system.

The increase in prevalence of reporting physician-diagnosed food allergy (which more than tripled from 0.39% to 1.43%) as well as in providing physician orders for EAI (which almost tripled from 0.26% to 0.74%) in the 6 school years in our study were consistent with other US studies documenting an increase in food allergy and other allergic disease. In a study from North Carolina schools during the 10-year period from 2004 to 2014, prevalence of self-reported severe allergy (not limited to food allergies) more than doubled, and physician orders for EAI more than tripled.²¹

The prevalence of documented food allergy (for 2012-2013, 1.43%) in this study was significantly lower than prevalence of food allergy among US children estimated from cross-sectional survey studies (5%-8%).^{1,2} Because reporting of food allergy diagnoses in this study relied on efforts by parents to access care, availability of clinicians to provide such care, and finally provision of a physician-completed form to the school, deficiencies in any of these areas could contribute to the prevalence of reported food allergy being significantly lower than estimates of true prevalence of food allergy among US children.

Table II. Comparison of indications for physician orders for epinephrine during school years 2007-2008 to 2012-2013 and for epinephrine administrations during years 2008-2009 to 2012-2013 within the NYC public school system

Diagnoses recorded as the indication for epinephrine*	Physician orders for epinephrine 2007-2008 to 2012-2013 (N = 30 818) n (%)	Epinephrine administrations 2008-2009 to 2012-2013 (N = 337) n (%)
Anaphylaxis to food	22 391 (72.7)	143 (42.4)
Anaphylaxis to unspecified food	1049 (4.7)	12 (8.4)
Anaphylaxis to specified food	21 342 (95.3)	131 (91.6)
Peanuts	13 670 (64.1)	99 (75.6)
Tree nuts and Seeds	2613 (12.2)	7 (5.3)
Shellfish	956 (4.5)	5 (3.8)
Eggs	670 (3.1)	1 (0.8)
Dairy (milk)	542 (2.5)	2 (1.5)
Fish	433 (2.0)	1 (0.8)
Fruits and vegetables	289 (1.4)	3 (2.3)
Other specified food	2169 (10.2)	13 (9.9)
Food intolerance	2042 (6.6)	—
Indication not documented	—	159 (47.2)
Anaphylaxis (unspecified cause)	5186 (16.8)	35 (10.4)
Asthma or reactive airway disease	500 (1.6)	—
Allergy, bee sting	192 (0.62)	—
Urticaria or angioedema	182 (0.59)	—
Other atopic disease	178 (0.58)	—
Anaphylaxis due to latex	119 (0.39)	—
Neurologic conditions	20 (0.06)	—
Gastrointestinal conditions	4 (0.01)	—
Hematologic conditions	2 (<0.01)	—
Immunologic conditions	2 (<0.01)	—

*This table summarizes what was reported on MAFs and does not imply that all listed diagnoses are Food and Drug Administration–approved indications for epinephrine (eg, food intolerance is not generally accepted as an indication for epinephrine).

As with prevalence of reported food allergy and physician orders for EAI, the yearly incidence of EAI administrations per 100 000 students increased significantly over 5 school years, almost tripling from 3.7 in 2008-2009 to 10.1 in 2012-2013. This increase may be explained partially by a true increase in incidence of anaphylaxis, in parallel with increases in allergic

disease, and corroborated by data from other school-based studies. The North Carolina school-based study similarly documented a rise in episodes of anaphylaxis (rather than EAI administrations), with a 2.2-fold increase over the 10 years of the study from 2004 to 2014.²¹ A Massachusetts school-based study reported much more modest increases in epinephrine administrations, by on average 9% per year, from 14.7 per 100 000 students in 2006-2007 school year to 17.6 per 100 000 students in 2010-2011 school year.²³ With increased staff-wide training over the past several years within NYC schools, it is likely that some of the dramatic increase in EAI administrations observed among NYC students is related to improved recognition of anaphylaxis and appropriate EAI use by nonmedical school staff.

The diverse, urban student population of NYC offers an opportunity to study the potential influence of sociodemographics on food allergy reporting, MAF status, and EAI administration. Odds of providing physician documentation of food allergy and physician orders for EAI were greatest among students that were younger, male, white, and of greater socioeconomic status (school lunch status used as a proxy). With these data being dependent on parent provision of physician documentation, food allergy and MAF data may be interpreted as representative of children whose families accessed care for allergy assessment and management. For EAI administrations, increased odds of requiring EAI were associated black race but did not appear to be influenced by age, sex, or socioeconomic status. With these data based on mandatory reporting by school nurses/staff, this is likely an accurate representation of children requiring EAI within NYC schools.

Foods were implicated as the inciting allergen for approximately 80% of EAI MAFs and 80% of EAI administrations with a known indication, consistent with data that food allergy is the most common cause of anaphylaxis in children.⁷⁻¹² Physician orders for EAI and in-school administration of EAI similarly implicated foods associated with persistent allergy as the most common culprits in food-associated anaphylaxis, with peanut being most common, followed by tree nuts and seeds, and shellfish. Foods less commonly associated with anaphylaxis,

Table III. Portion of students with documentation of physician-diagnosed food allergy who provided MAF for EAI each school year; EAI administrations per year; MAF status; and source of EAI for epinephrine recipients in the NYC public school system for each school year from 2007-2008 to 2012-2013

School years	Students with food allergy with EAI MAF* N (%)	EAI administrations n	MAF status of EAI recipients, n (%)			Source of EAI, n (%)		
			MAF before	MAF after	Neither before nor after	Stock	Student-specific	Not specified
2007-2008	2008 (50.1)							
2008-2009	2945 (51.7)	38	4 (10.5)	10 (26.3)	24 (63.2)	19 (50)	5 (13.2)	14 (36.8)
2009-2010	3570 (47.6)	35	6 (17.1)	8 (22.9)	21 (60)	18 (51.4)	8 (22.9)	9 (25.7)
2010-2011	4738 (47.5)	65	16 (24.6)	18 (27.7)	31 (47.7)	34 (52.3)	15 (23.1)	16 (24.6)
2011-2012	6253 (48.4)	86	18 (20.9)	25 (29.1)	43 (50)	46 (53.5)	18 (20.9)	22 (25.6)
2012-2013	7408 (46.5)	113	28 (24.8)	35 (31)	50 (44.2)	58 (51.3)	29 (25.7)	26 (23)
Total	26 922 (48.0)	337	72 (21.4)	96 (28.5)	169 (50.1)	175 (51.9)	75 (22.3)	87 (25.8)

*Data for school year 2007-2008 were only available for students with food allergy with EAI MAF.

namely fruits and vegetables, also made up a small but appreciable portion of foods implicated in food-induced anaphylaxis both on EAI orders and EAI administrations. In 2 other studies from schools, peanut was similarly the most commonly implicated food, accounting for 66% and 50% of reactions for which epinephrine was administered.^{20,22} Both this study (which included administrations of both student-specific and district-issued EAI) and a study from Chicago public schools (which was limited to district-issued EAI) found that a significant portion of EAI administrations in schools were without a specified indication (47.2% and 34.2%, respectively).²² It is not clear whether this is related to incomplete documentation or uncertainty of the indication at the time of administration.

In this study, the majority of students at risk for anaphylaxis relied on nonstudent-specific, stock EAI. The portion of documented food-allergic students with an EAI MAF on file was surprisingly low across all years, and decreased over the years of the study from 50.1% to 46.5% (Table III). This discrepancy across all years is likely related to food allergy diagnoses persisting in school-wide EHR in all subsequent school years after initial documentation, whereas EAI MAFs need to be updated yearly. Reasons for the decrease in portion of food-allergic students with MAF may include increasing awareness of the availability of stock EAI; rising cost or copayment associated with EAI purchase; and/or increase in diagnoses of non-IgE-mediated food allergies. More than one-half of EAI recipients were given stock EAI, and more than three-quarters of recipients were without EAI MAF at the time of administration. Although the use of stock EAI may be partially explained by first-time anaphylactic events occurring in school, only about one-third of EAI recipients without EAI MAF provided a student-specific physician order after an event. MAF provision among EAI recipients varied with race/ethnicity (with black and Asian students having lowest odds), but not socioeconomic status. Reasons for failure to provide EAI MAF among at-risk students may include varying cultural values, language barriers, dietary habits, or availability of medical care in neighborhoods enriched with certain races and ethnicities.

The importance of stock epinephrine in the management of in-school anaphylaxis has been reported in other school systems as well. The North Carolina study reported that the majority of students with self-reported severe allergy were without a student-specific physician order for EAI.²¹ School-based studies in Massachusetts (which included all in-school EAI administrations) and Chicago (which included only district-issued EAI administration) similarly reported a significant portion of EAI recipients without documentation of severe allergy before administration (24% and 55% of administrations, respectively).^{20,22} These data highlight that stocking and administration of nonstudent-specific EAI in schools, made possible by relatively recent policy changes, have been vital to management of anaphylaxis in schools. The data suggest that it is imperative for school staff to be prepared to diagnose and treat reactions in students without a student-specific order for EAI and without documented risk for anaphylaxis.

This reliance on stock epinephrine, even among those with history of food allergy or previous in-school EAI administration, highlights a significant unmet need for allergy evaluation of school-age students at risk for anaphylaxis. With the increasing incidence of EAI administrations, the rise in prevalence of reported food allergies, and concomitant decrease in the portion of those with food allergies providing EAI MAF, this unmet need appears to be growing. It is not clear whether increased awareness of the availability of stock epinephrine may have impacted families' decision to provide EAI and corresponding documentation. Addressing the gap between diagnosis of potentially severe allergy and provision of physician orders for EAI will likely require a collaborative approach, with involvement of physicians, families, and schools. Primary care physicians and allergists can lead the discussion with parents regarding the importance of providing accurate medical information to the school and of having an EAI available for their child in all settings, including in schools. School-based educational initiatives directed at students and parents can encourage parents of at-risk children to seek this counseling from medical professionals and to reinforce the necessity of having an EAI in school.

This study has several limitations. Food allergy reporting and provision of MAFs depend on parent provision of physician documentation to the school health office. As evidenced by the low prevalence of reported food allergy compared with survey studies, it appears there were a large portion of those with food allergy and those at risk of anaphylaxis who do not provide this documentation every year.^{1,2} Food allergy and MAF data should thus be interpreted as reflective of students successfully providing physician documentation of allergy and physician orders, rather than as generalizable to all food allergic students or all students at risk for anaphylaxis. Data for EAI administrations were not similarly limited by parent provision of physician documentations and orders; rather, these relied on accurate reporting by school nurses/staff. In a few cases, administrations had missing or partial demographic information, and many administrations were without a specified indication. It is not possible to ascertain whether the indication was truly unknown at the time of administration or if this was not completely documented. Where the indication was documented, it is possible that staff did not accurately identify and accurately record the provoking allergen. Furthermore, we cannot confirm whether all EAI administrations were indicated, as relevant details including signs and symptoms prompting administration were not available. In this study, EAI administrations are used as a proxy for severe reactions; however, it is suggested from one study that a significant portion of anaphylaxis events (25.3% from a Web-based school survey) may go untreated in schools.⁹ For future studies, it will be beneficial to understand additional details regarding administration of EAI, including type and severity of symptoms, source and location of exposure, time from trigger exposure or symptoms onset to administration of EAI, administering staff, and outcomes after EAI administrations. The exact timing and specifics of increased staff-wide training on EAI use were unavailable; future studies are needed to elucidate impact of

changes in school staff training on recognition and treatment of anaphylaxis and on incidence of epinephrine administration.

There were significant increases in prevalence of providing physician documentation of food allergy and student-specific EAI orders over the 6 school years from 2007-2008 to 2012-2013. Administrations of EAI tripled over 5 school years from 2008-2009 to 2012-2013. These findings may represent a true increase in prevalence of allergy and allergic reactions, increased reporting of allergic disease and reactions, and/or increasing appropriate use of EAI. With most at-risk students lacking student-specific EAI, availability of stock epinephrine is critical in the management of in-school anaphylaxis. Further, it is imperative that schools be prepared to treat students without known risk of anaphylaxis. Finally, to reduce risk and ensure appropriate management of allergic reactions in school, interventions are needed to identify students with potentially severe allergies. ■

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