

Disparity in the Availability of Injectable Epinephrine in a Large, Diverse US School District

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What is already known about this topic? In school districts where food allergy action plans have been implemented, practice inconsistencies have been described, and the reasons behind these inconsistencies are unknown. Minority children have the highest prevalence of food allergies, but the influence of ethnicity or socioeconomic status on the identification of children with food allergy or the presence of epinephrine injectors in schools has never been investigated.

What does this article add to our knowledge? In a large urban school district, epinephrine injectors were less likely to be found in low socioeconomic schools. Because minority students are disproportionately highly represented in low socioeconomic schools, there appears to be a disparity in availability of injectable epinephrine in Houston schools for minority students. A lower number of epinephrine injectors was also found in schools with students of limited English proficiency.

How does this study impact current management guidelines? When allergists speak with personnel at schools to inform about food allergies and treatment, they should know about the disparity in the availability of injectable epinephrine for students of lower socioeconomic status. These students with food allergies should be given injectable epinephrine and action plans for management of food allergies in school. Food allergy education should be provided to all families with children with food allergy, their physicians, and schools with students of both low and non-low socioeconomic status.

BACKGROUND: Food allergies affect 2.5% of the US population. Results of studies show that minorities have the highest prevalence of food allergies. The Houston Independent School District (HISD) has an urban, socioeconomically diverse population and the role of ethnicity and socioeconomic status (SES) with availability of epinephrine has not been explored in this population.

OBJECTIVE: This study sought to understand the association of SES and the presence of epinephrine in urban schools.

METHODS: A 6-item questionnaire about food allergy characteristics was sent by e-mail to one nurse per elementary school in the HISD to identify the number, characteristics and treatment of food allergic reactions, and the presence of epinephrine injectors. The reactions and presence of injectors were assessed for the previous school year. Schools were categorized by socioeconomic variables as "low" or "non-low" based on National School Lunch Program student participation.

Poisson, logistic, and linear regression analyses were used for group comparisons.

RESULTS: One or more children with food allergies were reported in 97% of responding schools, but only 43% of schools reported having epinephrine injectors. A larger number of injectors in schools were associated with students of higher SES ($r^2 = 0.701$; $P < .001$). There were 6 times more injectors in non-low SES schools than in low SES schools ($P < .03$). Low SES and limited English proficiency were associated with decreased epinephrine injectors in schools.

CONCLUSION: In the HISD, epinephrine injectors were more likely to be found in non-low SES schools versus low SES schools. Because minority students are disproportionately highly represented in low SES schools, there appears to be a disparity in the availability of injectable epinephrine for minority students in HISD schools. © 2013 American Academy of Allergy, Asthma & Immunology (J Allergy Clin Immunol Pract 2014;2:288-93)

Key words: Food allergy; Epinephrine; School; Socioeconomic status

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The current estimated prevalence of food allergies in North America is approximately 2.5%.¹ Prior studies have assessed the prevalence of food allergies by telephone surveys in an effort to obtain an accurate representation of the national population.²⁻⁵ Analysis of recent survey data suggests that the prevalence is 8% in the United States,⁵ with 6%-8% of school-age children affected.⁶ However, the perceived prevalence of food allergies ranges from 3% to 35% for any food.⁶ Currently, 8 foods (cow's milk, eggs, wheat, soy, tree nuts, peanuts, fish, and shellfish) are responsible for 90% of food-related reactions.⁷ Allergic reactions related to food are becoming more apparent in the school

Abbreviations used

CI-Confidence interval

HISD-Houston Independent School District

LEP-Limited English proficiency

NSLP-National School Lunch Program

SES-Socioeconomic status

environment. Approximately 18% of children with food allergy have reactions on school grounds,⁸ and 20% of anaphylactic reactions in schools occur after initial exposure to a food.⁹ Life-saving treatment for food allergic reactions in schoolchildren includes prompt administration of injectable epinephrine. A prior anonymous survey of school nurses showed a need for increased education and guidelines regarding proper treatment of reactions.¹⁰ However, in school districts where food allergy action plans have been implemented, practice inconsistencies have been described.¹¹ The reasons behind these inconsistencies are unknown.

Race plays a role in the expression of childhood food allergy.^{1,5,12,13} A recent National Health and Nutrition Examination Survey study showed minority children, specifically non-Hispanic boys, have the highest prevalence of food allergies.¹ Gupta et al⁵ report the odds of food allergy as significantly higher among Asian and black children versus white children, but the odds of a confirmed food allergy was lower among Asian, black, and Hispanic children versus white children. A study of Massachusetts school students showed that, when 3 school districts were compared, white schoolchildren were 6 times more likely to be dispensed epinephrine injectors than all other races.¹³ Research has not been performed to determine if ethnicity or socioeconomic status (SES) influences the identification of children with food allergy or the presence of epinephrine injectors in schools. A questionnaire was administered to school nurses in a large urban school district to determine the impact of ethnicity and/or SES on the number of students with food allergy, determination of causal foods, the number of epinephrine injectors at the school, food allergic reactions, and the characteristics and treatment of reactions on school grounds.

METHODS

Location

The Houston Independent School District (HISD) has a unique culturally and socioeconomically diverse population of more than 200,000 students and is an ideal district to determine the effect of the SES and ethnicity on the identification of food allergies and epinephrine injectors in the schools. During the 2010-2011 school year, the majority of HISD students were Hispanic (61.7%), whereas 26% were African American, 7% white, and 3% Asian.

Nursing questionnaire

A 6-item questionnaire was developed by using published guidelines for questionnaire design¹⁴ and was sent by e-mail to all HISD elementary school nurses (n = 170), with one nurse representing each school. The nurses were asked to review their student records in completing the questionnaire. The survey sought to address the following topics: (1) the number of students with food allergy, (2) epinephrine injectors, (3) allergic

TABLE 1. Ethnic distribution of students in the HISD by SES

Ethnic group	SES	Student (% mean)	95% CI	P value
African American	High	17.5	9.3-25.7	.06
	Low	28	20.7-35.1	
American Indian	High	0.4	0.2-0.6	.24
	Low	0.23	0.1-0.4	
Asian	High	10.1	5.5-14.8	<.001
	Low	1.3	0.5-2.0	
White	High	30.7	22.4-39.1	<.001
	Low	2.3	1.4-3.2	
Hispanic	High	39.3	30.6-47.9	<.001
	Low	68.1	61.0-75.0	
Mixed ethnicity	High	2.1	1.5-2.7	<.001
	Low	0.3	0.2-0.5	

reactions per school, (4) causal foods, and (5) the characteristics and treatment of reactions (see [Appendix E1](#) in this article's Online Repository at www.jaci-inpractice.org). When the survey was distributed, the teachers were asked to report children with physician-documented food allergy by food allergy action plans, so, in this way, intolerance was distinguished from true food allergy. Reports of food allergies were based on physician documentation as well as food allergy action plans during the 2010-2011 school year. All the schools that reported were elementary schools. School SES was based on the percentage of children enrolled in the National School Lunch Program (NSLP). The percentage of public school students eligible for free or reduced-price lunches in a particular school is strongly related to child poverty among students in that school.¹⁵

The percentage of students eligible for the NSLP as a measure of low SES in a school ranges from 30% to 90%.¹⁵⁻¹⁷ Schools have been classified in previous studies as low SES if approximately 80% of children qualify for free or reduced-price lunch, and, if only 40% of students were eligible, then schools were considered middle or non-low SES.^{18,19} In Texas, on average, approximately 58% of students are eligible for free or reduced-price meals.¹⁹ Because there are no accepted classifications, a cutoff higher than the average was set with $\geq 70\%$ student participation in the NSLP used to classify a school as low SES. The other schools were considered non-low SES schools. The HISD reports the yearly student participation in the NSLP for each school.

Statistical analysis

Poisson, logistic, and linear regression analyses were used for group comparisons on count, binary, and continuous variables, respectively, while controlling for covariates as indicated. The odds ratio is provided with results of logistic regression when appropriate. Descriptive statistics are presented as mean with 95% CI. Institutional review board request for this research was submitted and approved by Baylor College of Medicine. The study was approved by the HISD Research and Development Department.

RESULTS

Nurse response

Fifteen non-low SES and 74 low SES schools participated for an overall response rate of 52% of all HISD schools (89/170),

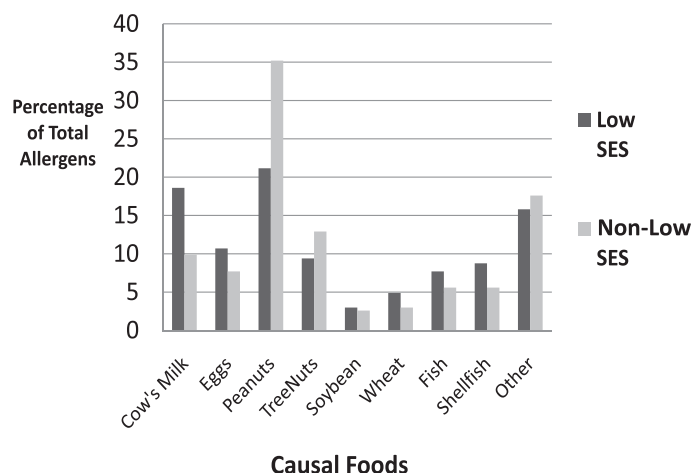


FIGURE 1. Causal food allergens in HISD by SES.

which represented 69,310 students. The response ratio of 4.9 of low to non-low SES school nurses was similar to the overall ratio in the entire population of HISD elementary schools (4.2). The difference in ethnic composition of the non-low and low SES school groups was significant ($P < .001$). Hispanic students (mean, 68% [95% CI, 61.0%-74.9%]) comprised the majority of students in low SES schools, followed by African-American students (mean, 28% [95% CI, 20.8%-35.1%]). White students only comprised 2% of low SES students. In non-low SES schools, the students were mainly Hispanic (mean, 39% [95% CI, 30.6%-47.9%]) and white (mean, 30.7% [95% CI, 22.3%-39.0%]), with African-American students comprising only 17% of the student body. Students of Asian descent were more likely to be enrolled in non-low SES schools (mean, 10.1% vs 1.3% in low SES) (Table I). Eighty-six nurses (97%) reported having 1 or more students with food allergy.

Association of ethnicity and SES with the number of epinephrine injectors and causal foods

If the number of epinephrine injectors was evaluated per school as a proxy for students with allergy, the overall prevalence of nurse-reported allergy in the HISD student population was 2.4% (1.4% in low SES schools and 6.4% in non-low SES schools). The possibility that the number of epinephrine auto-injectors overestimated children with food allergies was assessed by a follow-up survey the subsequent year, which showed the median (range) of reported epinephrine autoinjectors and children with food allergy as 4 (0-10) and 12 (1-59), respectively. The number of epinephrine injectable pens was never higher than the number of children with food allergies in any one school. Results of subsequent surveys showed large discrepancies in the number of children with life-threatening food allergies and injectable epinephrine available to treat them, with only 75% having epinephrine on campus. The difference between the number of epinephrine injectors at non-low and low SES schools was statistically significant ($P < .001$). Peanuts (26%), cow's milk (16%), tree nuts (11%), and eggs (10%) were the most frequently reported allergens, regardless of SES (Figure 1). Tree nut allergies were more common in non-low SES schools and cow's milk allergy in low SES schools. Schools with children with peanut ($P < .001$), tree nut ($P < .001$), fish ($P = .022$), cow's

milk ($P = .024$), and egg ($P = .031$) allergies were more likely to have epinephrine injectors in that school, regardless of SES. Schools with children with peanut allergy were more likely to have epinephrine injectors than other schools regardless of SES (odds ratio, 1.8; $P < .01$).

Association of ethnicity and SES with epinephrine injector presence

Only 43% of the participating schools had student-specific epinephrine injectors. Ninety-seven percent of schools with fewer than 4 injectors were classified as low SES schools and only 33% of non-low SES schools had fewer than 4 injectors. Also, a larger number of epinephrine injectors were associated with fewer students who participated in the NSLP ($r^2 = 0.701$; $P < .001$) (Figure 2, A). Schools with non-low SES were 6 times more likely to have epinephrine injectors, even when accounting for the number of students with food allergies ($P < .03$) (Figure 2, B).

Both Hispanic ethnicity and limited English proficiency (LEP) were more prevalent in low SES schools ($P < .001$). When ethnic differences were analyzed, the number of epinephrine injectors was positively correlated with increasing numbers of white students ($r^2 = 0.665$; $P < .001$). Meanwhile, an inverse correlation was noted with the percentage of African-American students ($r^2 = 0.56$; $P = .017$). However, when controlling for SES, most ethnic relationships with epinephrine presence disappeared, which suggests that the differences in school SES accounted for all relationships between ethnic distribution and the number of epinephrine injectors at an individual school. The direct relationship between the proportion of white students and epinephrine injectors still approached significance ($P < .07$).

Further analysis showed an inverse correlation between the number of epinephrine injectors per school and the percentage of students with LEP (Figure 3). As the percentage of students with LEP decreased, the number of epinephrine injectors increased ($r^2 = 0.367$), but this was not statistically significant ($P > .05$). No correlation between LEP and the number of epinephrine injectors was noted for the low SES group ($r^2 = 0.008$). The mean percentage of students with LEP was 19.13% (95% CI, 13.82%-24.45%) in the non-low SES group, and, in the low SES group, this was higher, at 44.51% (95% CI, 39.6%-49.6%). When considered simultaneously, both SES ($P < .001$) and

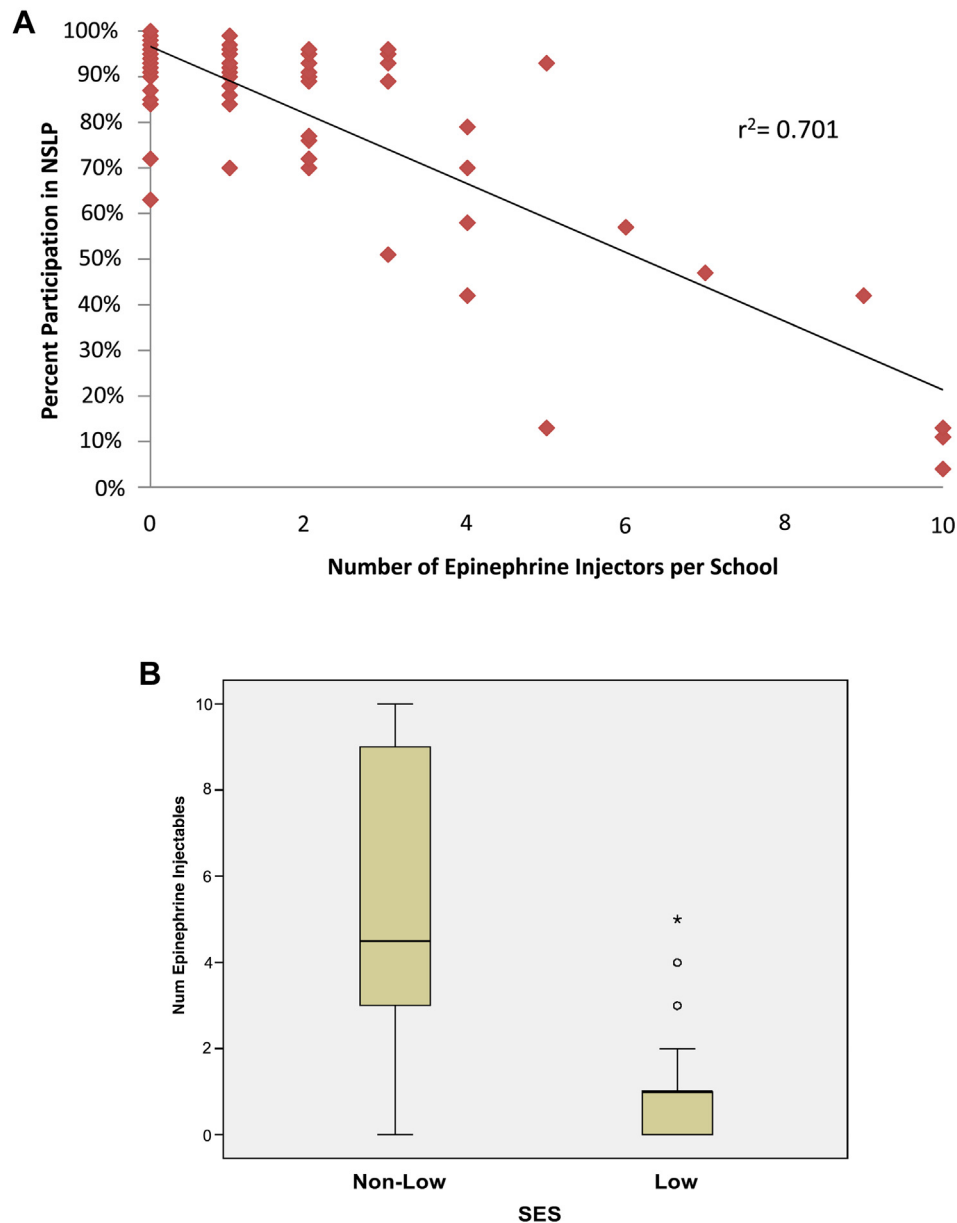


FIGURE 2. **A**, Association of participation of National School Lunch Program with the presence of epinephrine injectors. **B**, Distribution of epinephrine injectors by SES (number of epinephrine injectables reported by each school nurse).

proficiency of the English language ($P < .01$) were found to be independently associated with the number of epinephrine injectors.

Association of ethnicity and SES with food-related reactions at school

Eleven percent of schools reported having a food-related reaction on school grounds. Three schools had 2 reactions during the year, with the remainder of schools having only 1 reaction. The most common symptoms reported were hives, itchy rash, and/or swelling about the face and/or extremities. One student had respiratory difficulty but no laryngeal symptoms. All 13 reactions that occurred on school grounds were treated solely with antihistamine. Overall, the number of nurse-identified

reactions was small, and there was no association with school ethnicity or SES.

DISCUSSION

This study in a culturally diverse large school district explores the availability of injectable epinephrine in urban schools with students of low and non-low SES. This is an important aspect in the preparedness to treat food allergic reactions in schools. Although more than 90% of the participating schools reported children with food allergy, fewer than 60% of schools had one or more student-specific epinephrine injectors available. Most of the schools without injectors were of low SES. The prevalence of food allergy in non-low SES schools in HISD was congruous

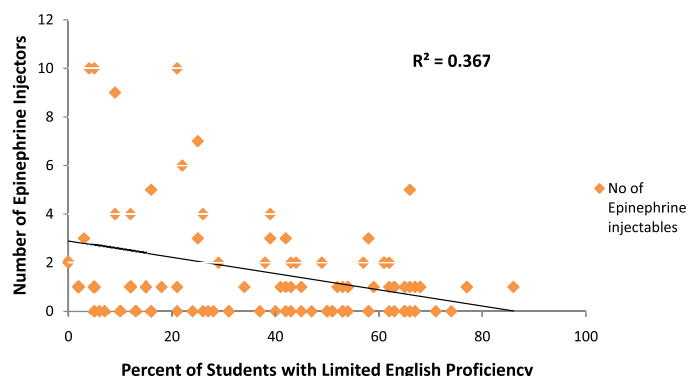


FIGURE 3. Relationship of epinephrine injectors to percentage of students with LEP.

with the known prevalence from national surveys (approximately 6%) but the prevalence in low SES was much lower than the national prevalence (approximately 1%), which suggests under-recognition of food allergy in schools with students of low SES. Analysis of these findings suggests that the identification of food allergies in schools in this urban setting is related to student SES. However, other factors may contribute to what is likely a multifactorial problem.

Ethnic predominance of school students did not seem to play a role in these findings after accounting for SES but may still be important in follow-up studies because of the direct relationship observed in the HISD between the proportion of white students and the presence of epinephrine injectors, which approached significance despite controlling for SES. This finding is consistent with previous research that documented whites as approximately 5 times more likely than nonwhites to be dispensed injectable epinephrine for peanut or tree nut allergy, and almost 9 times as likely to be dispensed injectable epinephrine for stinging insect allergy.¹³ However, the role of ethnicity has not been explored before in a large urban, socioeconomically diverse school district with several minority groups (Hispanic, African American, and Asian). National surveys have identified food allergy as more prominent in minority children,⁵ and, in a multiethnic birth cohort, black children were more likely to be sensitized to food allergens.¹² Given the correlation between higher minority ethnic composition and low SES in HISD schools and national studies, which indicates higher food allergic disease in these populations, one would expect more children with food allergy in low SES schools. However, analysis of the above data suggests that fewer children have nurse-identified food allergy in low SES schools, which indicates a health disparity.

The reasons for this health disparity are unknown. However, several possible hypotheses should be considered. First, in many families of lower SES, there is an inability to obtain regular medical services because of inconvenience from a lack of transportation, missed wages, a lack of medical insurance coverage, or other financial reasons.²⁰ These factors, incorporated with a poor understanding of the signs and symptoms of food allergies, may prevent families from seeking proper medical attention.²⁰ Families of higher SES may have higher financial means and access to medical care. In addition, a higher level of education may attribute to increased understanding of food allergy symptoms, which may prompt families to seek medical assistance more often. This is consistent with what has been documented in

families with children with asthma.²⁰⁻²³ Survey studies of families with asthma determined family characteristics, such as a lack of knowledge regarding asthma and its control and medical compliance, and environmental barriers, such as financial and social constraints, were the most frequent barriers to care.²⁰

LEP was associated with lower epinephrine injectors in schools. As the percentage of students with LEP decreased, the trend was for the number of epinephrine injectors to increase. When SES and proficiency of the English language were evaluated simultaneously, both were significantly associated with the number of epinephrine injectors. Therefore, LEP may be one of the barriers to identification of food allergy in minority students and having epinephrine injectors at a school with minority children with food allergies. LEP populations have increased morbidity with diabetes and asthma,^{24,25} so safety in school for minority children with food allergies may also be influenced by LEP.

Peanuts were the most implicated food allergen in HISD schools (26% of all food allergies). This finding is in line with historic data, which suggests that peanut allergies are the most common food allergen in the United States.⁷ Cow's milk, tree nuts, and eggs followed as the next most commonly reported allergens. Analysis of our data supports previous reports of perceived prevalence of food allergy for milk and eggs.³ SES and ethnicity did not significantly affect these findings.

The potential limitations of this study include the response rate of 52%, which may have overrepresented segments of the population. However, this response rate is comparable with other school nurse surveys of food allergy prevalence in schools, which range from 38% to 64%.¹¹ Another limitation is the overrepresentation of low SES schools, but, given the predominance of low SES schools in the HISD, this was difficult to avoid. Recall bias and dependence upon nurse perception of food allergy is another limitation. Prospective studies can be performed in the future to minimize this bias. Also, this observational survey study cannot establish cause and effect.

In conclusion, there appears to be a disparity in the availability of injectable epinephrine in schools with underserved populations in this large urban diverse school district. The disparity is most pronounced in schools of low SES and is related to ethnicity and LEP. More studies will be needed to elicit the causes of this disparity and the proper modality of teaching food allergy awareness and management for school personnel and families of children with food allergies in minority communities. Allergists and other

health care providers should be aware of the potential inadequate preparedness to treat food allergies in children who are underserved and of low SES.

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Appendix E1. Needs assessment questions for HISD school nurses

1. What is the name of your school? _____
2. How many epinephrine injectable pens do you currently have for students enrolled in your school? _____
3. To which foods are your students known to have allergies? For each food, please list the number of students with the allergy to that food.

Food	No. students allergic
Cow's milk	_____
Egg	_____
Peanuts	_____
Tree nuts	_____
Soybean	_____
Wheat	_____
Fish	_____
Shellfish (shrimp and fish)	_____
Other	_____

4. Has a student in your school had a food-related allergic reaction on school grounds during this school year?

Yes No

If so, how many reactions have occurred? _____

5. Please circle the symptoms with which the students presented.

Itching and swelling of the lips, tongue, or mouth	"Thready" pulse, "passing out"
Tightness in the throat, hoarseness, and hacking cough	Hives, itchy rash, and/or swelling about the face or extremities
Nausea, abdominal cramps, vomiting, and/or diarrhea	Shortness of breath, repetitive coughing, and/or wheezing

6. Have you had to use an epinephrine injectable pen (Epipen [Mylan Specialty LP, Basking Ridge, NJ] or Twinject [Amedra Pharmaceuticals LLC, Horsham, Pa]) or diphenhydramine (Benadryl, McNEIL-PPC, Inc, Fort Washington, Pa) for a reaction this school year?

Yes No

If yes, epinephrine _____ (no. of times); diphenhydramine _____ (no. of times)