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Abstract

Background. Increasingly, teachers are the first respondents to food allergic reactions in schools. Studies of food allergy in school settings have identified deficiencies in teacher recognition and treatment of reactions. We sought to determine the effect of a didactic session on teacher knowledge of the causative foods, symptoms, and treatment of reactions in diverse elementary schools. **Methods.** An educational intervention project using a pretest–posttest control group design was performed. Teacher knowledge about food allergy causes, symptoms, and treatment of food allergic reactions was assessed. **Results.** The average percentage of correctly answered questions by teachers at baseline for each school ranged from 60% to 68%. After education, teachers at the intervention schools answered 24.6% to 34.6% (confidence interval = 21.5–74.1 and 32.1–103.9, respectively) more questions correctly compared with 4.0% to 4.3% (confidence interval = 2.5–21.6 and 0.9–31.0, respectively) in control schools. **Conclusions.** Education significantly increased teacher knowledge of food allergy causes, symptoms, and treatment of food allergic reactions in diverse schools.

Keywords

food allergy, school, education, socioeconomic status

Background

Prior studies have assessed the prevalence of food allergies by surveys in an effort to obtain an accurate representation of the national population.^{1–5} The prevalence of food allergies through patient self-report ranges from 3% to 35% for any food.⁶ Several publications show an increased incidence of food allergies, specifically tree nut and peanut allergies, over the past decade.^{2–4,6} Currently, 8 foods (cow's milk, eggs, wheat, soy, tree nuts, peanuts, fish, and shellfish) are responsible for 90% of food-related reactions.⁷

Food allergies affect about 1 in 13 school-age children.^{5,6} Forty percent of food allergic children are judged to have a high risk of anaphylaxis.⁸ Nearly 25% of peanut/tree nut-induced allergic reactions in school or day care were reported to occur before diagnosis.⁹ One in 5 children with food allergies will have a reaction while in school.¹⁰ All previously reported fatal food anaphylaxis episodes are associated with delayed administration of epinephrine, the treatment for food-induced anaphylaxis.¹¹ Unsuccessfully managed anaphylaxis can result in death. Therefore, since death from anaphylaxis can occur in school settings, recognition and treatment of

food allergic reactions is essential for child safety in schools.

Allergic reactions related to food are becoming more frequent in the school environment. Approximately 18% of all food allergic children have reactions on school grounds,¹² and 20% of anaphylactic reactions in schools occur after initial exposure to a food.¹³ The need for the dissemination of established best practices and for administrators and teachers to be familiar with the management of food allergies is increasing.

A questionnaire survey of school teachers revealed that primary school teachers are not well informed about food-induced reactions or the causes of these reactions.¹⁴ National programs for education of school personnel currently exist for asthma education but not for food allergies.¹⁵ Without education, increasing food allergy

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awareness among school staff frequently depends on parents' attempts to educate teachers. In school districts where food allergy action plans are required for food allergic children, practice inconsistencies have been described.¹⁶ Studies show that teachers are not knowledgeable about food allergies.¹⁴ Although educational materials have been developed for use for physicians and patients,¹⁷⁻²⁰ no food allergy educational interventions have been evaluated for teachers in the school setting. Thus, there is a need for research to evaluate the effectiveness of educational interventions to teachers in schools.

To fill the gap in the literature, this study sought to answer the following 3 questions in a diverse large urban school district. Is there improvement in knowledge about food allergies in teachers after educational intervention? Is baseline teacher knowledge of food allergies different between schools with different percentages of National School Lunch Program (NSLP) student participation? Is there a difference in the effect of the educational intervention between schools with a lower and higher percentage of NSLP student participation? This study was designed to answer these important questions.

Methods

Participants

To identify schools with similar education needs based on the number of food allergic children, an 8-item questionnaire was e-mailed to all Houston Independent School District (HISD) elementary school nurses ($n = 170$), with one nurse representing each school (Appendix A). The questionnaire was used only for school recruitment purposes to ensure the numbers of food allergic children in intervention and control schools were not disparate. Intervention and control schools were also matched for socioeconomic status [SES] based on the percentage of children enrolled in the 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 of that school. The percentage of students eligible for the NSLP as a measure of low student SES in schools range from 30% to 90%.^{21,22}

Schools have been classified in previous studies as low SES if ~80% of children qualify for free or reduced-price lunch. If only 40% of students were eligible, schools were considered middle or "not low" SES.^{23,24} In all Texas students, ~58% are eligible for free or reduced-price meals.²⁴ A cutoff of greater than or equal to 90% student participation in NSLP was used to classify schools as having higher student NSLP in this study,

whereas schools with fewer than 58% of students enrolled in NSLP were considered schools with lower student NSLP participation. Because the first responders in the event of a student food allergic reaction are frequently in the classroom,¹² teachers attending quarterly staff meetings were included in the study.

Instruments

Didactic Session. A 1-hour teaching session regarding food allergies was developed, including essential topics determined for the understanding of food allergic reactions. A PowerPoint presentation was administered by a physician containing the following topics: prevalence of food allergies, causal foods, signs of local and systemic reactions, and methods for prevention and treatment for food allergies. School personnel knowledge of the topics was assessed through the following questionnaire (Appendix B).

Questionnaire. A questionnaire was developed using the steps to create an effective instrument, with expert and draft pilot administration.²⁵ The original 30 developed questions corresponded to specific objectives in the didactic presentation. An expert panel of allergists and public health experts reviewed the questionnaire, which was revised accordingly. Further peer review was obtained by providing the original 30-question survey to physicians at Baylor College of Medicine. Questions with incorrect responses by experts or those determined as inappropriate for target audience by the panel were eliminated. The final questionnaire consisted of 2 subjective items scored on a Likert-type scale (with 1 representing very unfamiliar/uncomfortable to 5 representing very familiar/comfortable) to reflect familiarity with food allergies and comfort with reaction prevention, and 8 items of single best answers. The objective items were scored as either correct or incorrect (see Appendix B).

Procedure

Teachers at 4 HISD elementary schools were selected, 2 with lower and 2 with higher percentage of NSLP student participation, to participate in a questionnaire administration designed to understand food allergy knowledge (Figure 1). Approximately 30 schools were identified based on availability of teacher time for the didactic session and, of the available schools, 4 were chosen randomly based on matched number of epinephrine injectors used as a proxy for food allergic children. One school from each arm was randomly chosen to receive the educational session regarding food allergies.

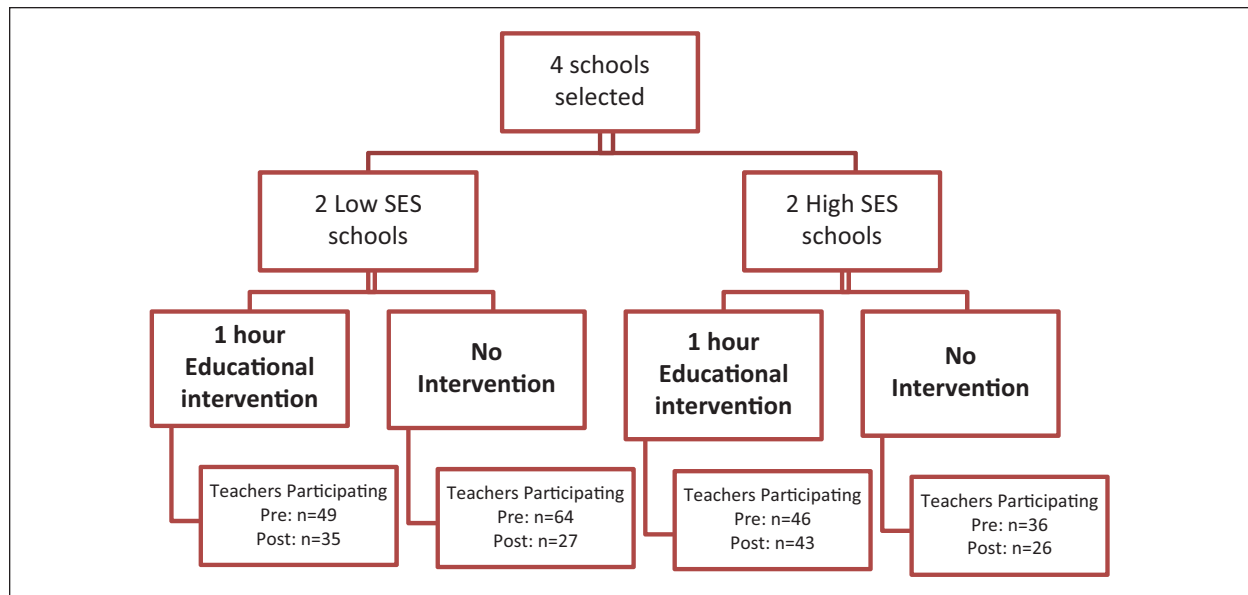


Figure 1. Questionnaire administration design (SES = socioeconomic status).

Teachers at all 4 schools completed the same questionnaire twice ($n = 195$, pre-intervention, and $n = 131$ post-intervention). The intervention schools received the educational didactic session and the control schools did not. The intervention schools received the pretests and posttests right before and after the 1-hour session. The control schools received the pretests and posttests within a 1-month time period. All 4 schools were provided with a copy of the Food Allergy and Anaphylaxis Network's guide "School Food Allergy Program" (<http://www.foodallergy.org>) for their participation after intervention.

Data Analysis

Questionnaire results were analyzed based on overall percentage of questions answered correctly. Confidence intervals (95% CIs) were used to establish significance of results with SAS (SAS Institute, Inc, Cary, NC). Nonoverlapping confidence intervals were used as evidence of statistical significance. Determination of improvement in knowledge about food allergies in teachers after educational intervention was analyzed by comparing percentage of questions answered correctly before and after educational intervention. Baseline teacher knowledge of food allergies in low- and non-low-SES schools was determined by comparing the percentage of questions answered correctly at baseline in the 2 schools with higher NSLP student participation ($>90\%$) versus the 2 schools with lower NSLP student participation ($<58\%$). The difference in the effect of the

educational intervention between the socioeconomically differing schools was determined by comparing percent of questions answered correctly from pretest and posttest scores for the intervention schools versus control.

Human Subjects Approval Statement

Institutional review board request was submitted and approved by Baylor College of Medicine. The subject's answering of the questionnaire was adequate for written consent. Our proposal was also submitted, reviewed, and approved by Houston Independent School District Research and Development Department.

Results

This study sought to understand if there was improvement in knowledge about food allergies in teachers after educational intervention. The number of teachers participating in the program ranged from 26 to 64 per school. The mean dropout rate for each school was only 30% between pre and post questionnaire administration. Personnel at all schools were able to correctly answer 50% to 68% of survey questions correctly at baseline (Table 1.) School personnel who received the intervention session had a higher improvement in understanding of causal foods, signs of anaphylaxis, and proper treatment of local and systemic reactions afterward compared with control school personnel. After the educational session, participants at the school with higher NSLP

Table 1. Percentage of Questions Answered Correctly by Teachers at Schools With Higher NSLP Student Participation (>90%) Versus Lower NSLP Student Participation (<58%) Before and After Educational Intervention.

Question	>90% NSLP Control	>90% NSLP Intervention	<58% NSLP Control	<58% NSLP Intervention
Treatment of local reaction				
Pre	14.1	22.4	38.9	37.0
Post	29.6	82.9	56.0	74.4
Percentage change ^a	110.7	270.1	44.0	101.1
Treatment of systemic reaction				
Pre	45.3	49.0	80.6	70.0
Post	48.1	94.3	76.0	95.3
Percentage change	6.3	92.5	-5.7	36.2
Histamine causes allergies				
Pre	67.2	26.5	69.4	65.2
Post	63.0	82.9	80.0	95.3
Percentage change	-6.3	212.8	15.2	46.2
Prevalence of food allergies				
Pre	37.5	36.7	44.4	35.0
Post	48.1	74.0	52.0	79.0
Percentage change	28.4	101.6	17.0	125.7
Definition of anaphylaxis				
Pre	60.9	55.1	88.9	82.6
Post	66.7	88.6	88.0	97.7
Percentage change	9.4	60.8	-1.0	18.3
Time from reaction to treatment				
Pre	81.3	83.7	86.1	89.1
Post	77.8	94.3	84.0	100.0
Percentage change	-4.3	12.7	-2.5	12.2
Causal foods				
Pre	77.1	76.5	76.0	78.3
Post	77.8	98.6	80.3	94.6
Percentage change	0.1	28.9	5.7	20.8
Signs of anaphylaxis				
Pre	53.8	51.9	59.2	49.8
Post	57.8	62.7	61.6	67.7
Percentage change	4.0	6.5	5.9	36.0
Average percentage correct				
Pre	54.6	50.2	67.9	63.4
Post	58.6	84.8	72.2	88.0
Percentage increase	4.0	34.6	4.3	24.6
95% confidence interval	0.9-31.0	32.1-103.9	2.5-21.6	21.5-74.1

Abbreviation: NSLP, National School Lunch Program.

^a(Average percentage correct pre-intervention - Average percentage correct post-intervention) ÷ Average percentage correct pre-intervention.

student participation (>90%) versus the school with lower NSLP student participation (<58%) had a 34.6% increase (CI = 32.1-103.9) and 24.6% increase (CI = 21.5-74.1), respectively, in the number of questions answered correctly, when compared with 4% (CI = 0.9% to 31%) and 4.3% increase (CI = 2.5% to 21.6%), respectively, for the higher and lower NSLP student participation control schools (Table 1).

Improvement was noted in participants' ability to recognize the 8 most common foods responsible for

food allergies, including the recognition of soy and wheat as common allergens (pre-intervention, 41% and 75% correct for soy and wheat, respectively; post-intervention, 96% and 99% correct, respectively) and elimination of strawberries as a common allergen (pre-intervention 29% correct; post-intervention 72% correct). Other questions with a high overall improvement included teachers' ability to recognize treatment for local and systemic reactions. There was an increased familiarity and comfort with treatment of food allergies

after the intervention with average increase from 3 (somewhat familiar/comfortable) to 4 (familiar/comfortable) on the 5-item scale.

We sought to answer the second question about the relationship between baseline teacher knowledge of food allergy in schools with higher and lower student NSLP participation. Baseline teacher knowledge of food allergy as measured by correctly answered questions was not significantly different between schools higher and lower student NSLP participation. However, the baseline teacher knowledge of food allergies at the schools with lower NSLP participation was numerically higher than the baseline at schools with higher NSLP participation (Table 1). The number of injectable epinephrine pens identified at the schools with lower NSLP participation was 6 and 9, but only 1 epinephrine pen was identified in each of the schools with higher NSLP participation.

The difference in the effect of the educational intervention between schools with students of higher and lower NSLP participation was assessed through correctly answered questions after education. The percentage increase in food allergy knowledge in schools with lower and higher percentage of NSLP student participation after intervention showed overlapping CIs, indicating teachers answered questions similarly correct in both schools. However, the percentage change in knowledge of food allergies at the schools with higher percentage of NSLP student participation was larger than the schools with lower percentage of student NSLP participation, possibly because the baseline knowledge of food allergies was lower at the schools with a higher percentage of NSLP student participation (Table 1).

Discussion

To our knowledge, this is the first study in an economically diverse large school district to assess the effectiveness of an educational food allergy intervention in schools with differing student SES. Although this study showed the student SES of a school was not significantly associated with teachers' baseline knowledge about food allergies, the study did note that teachers receiving a specific educational session regarding food allergies had a significant increase in their knowledge of the recognition and treatment of food allergies over those not receiving the session. The effect was robust in both schools with higher (>90%) and lower (<58%) student NSLP participation. The baseline knowledge was higher in the schools with more epinephrine pens identified, suggesting some small effect from the presence of food allergic children on teacher knowledge of food allergies. Although personnel from 2 schools from only 1 school district received this intervention, larger

follow-up studies need to determine if educational interventions like this will be effective in diverse environments as more school districts adopt and implement food allergy management guidelines.

The greatest impact of this educational intervention was the improvement of the teachers' knowledge of the appropriate treatment of a systemic allergic reaction (anaphylaxis) as the immediate use of epinephrine, from ~50-70% to greater than 94% of teachers understanding this fact. The results of several studies support the fact that significant time delay in giving epinephrine leads to fatalities.¹¹ Teachers were initially unaware that food allergies could occur in their classroom. The increase in knowledge of the prevalence of food allergy (1 in 13 children⁵) through this intervention will hopefully lead to improved behavior and attitude of teachers in the schools toward food allergy. The effect of education on behavior and attitudes needs further study.

With a recent decrease in full-time school nurses, teachers face difficulties and feel overwhelmed when given the responsibility to care for students with food allergy.²⁶ A comprehensive educational program for teachers is considered imperative when no school nurse is available.²⁶ The American Academy of Pediatrics recommends that the management of food allergy in the school setting includes providing resources for school officials to help them develop food allergy management protocols.²⁷ This includes designating adults responsible for treatment of food allergic reactions.²⁷

This study offers steps toward validation of an educational method for school teachers that could be used on a larger scale. Physician and school nurse educators can play an important role in educating school personnel about the treatment of food allergies. However, further studies will be needed to ascertain whether the implementation of education on a larger scale and increased knowledge about food allergy translate into improvement in safety and quality of life of school aged children with food allergies.

This study was not powered or designed to define the impact of food allergy management guideline interventions in the safety and quality of life of school aged children with food allergies. The questionnaire was also not designed to test whether school personnel would actually be able to correctly administer necessary treatments. The high dropout rate in one of the control schools may have contributed to selection bias. Future plans include conducting our survey with unique identifiers to provide individual feedback to educators and nurses who interact with children with food allergy and assessment of quality of life of food allergic children and their families before and after intervention. Also, follow-up surveys will be conducted to determine how long the knowledge lasts and if subsequent educational sessions are required for long lasting retention of knowledge.

There is a need for education of nonmedical personnel regarding the treatment of food allergic disease in schools in urban school districts. A focused 1-hour educational intervention improved the knowledge of school personnel so that they may be better prepared to respond immediately to food allergic reactions in school. This educational intervention, developed based on needs assessment, showed educational value and improvement in comfort of teachers with treatment of food allergy.

Implications for Children's Health

Focused didactic educational intervention for teachers at diverse schools with higher (>90%) and lower (<58%) student NSLP participation is effective in increasing knowledge and comfort level in the recognition and treatment of food allergy. Given the importance of training for effective school food allergy management plans, didactic methods for training should be considered for school personnel.

Appendix A

Questions for Houston Independent School District 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	Number of 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® or TwinJect®) or diphenhydramine (Benadryl®) for a reaction this school year?
Yes No If yes, Epinephrine _____ (# times)
Diphenhydramine _____ (# times)

Appendix B

Houston Independent School District Food Allergy Questionnaire: Teachers

INSTRUCTIONS: Please circle the most appropriate response below. All of your answers will be completely confidential.

1. How familiar are you with food allergies?

Very Unfamiliar	Unfamiliar	Somewhat Familiar	Familiar	Very Familiar
1	2	3	4	5

2. How comfortable do you feel with preventing an allergic reaction?

Very Uncomfortable	Uncomfortable	Somewhat Comfortable	Comfortable	Very Comfortable
1	2	3	4	5

3. Which of the following foods are among the 8 most commonly responsible for food allergies?

Cow's milk	Yes	No
Tree nuts	Yes	No
Rice	Yes	No
Beef	Yes	No
Fish	Yes	No
Eggs	Yes	No
Oats	Yes	No
Peanuts	Yes	No
Strawberries	Yes	No
Soy	Yes	No
Wheat	Yes	No
Shellfish	Yes	No

4. Which of the following symptoms represents a systemic (severe) reaction to food?

Skin swelling	Yes	No
Itchiness	Yes	No
Difficulty breathing	Yes	No
Fear of impending doom	Yes	No
Nausea	Yes	No
Low blood pressure	Yes	No
Fainting	Yes	No
Chest pain	Yes	No
Pallor	Yes	No
Sneezing	Yes	No

5. What is the proper management for a LOCAL reaction after an allergic reaction?

- Call the parents and have them take the child home
- Give Benadryl, monitor, and call physician
- Give Epinephrine injection and send the child home
- Give Epinephrine injection and call EMS

6. What is the proper management for a SYSTEMIC reaction after an allergic reaction?
 - a. Call the parents and have them take the child home
 - b. Give Benadryl, monitor, and call physician
 - c. Give Epinephrine injection and send the child home
 - d. Give Epinephrine injection and call EMS
7. Which substance is responsible for allergic reactions?
 - a. Serotonin
 - b. Epinephrine
 - c. Histamine
 - d. MSG
8. In an average classroom of 30 children, how many are at risk for having a food allergy?
 - a. 1
 - b. 2
 - c. 5
 - d. 10
9. What is the definition of anaphylaxis?
 - a. Hives, itchy rash, and sneezing
 - b. Serious and fast allergic reaction that may cause death.
 - c. An inability to pay attention and racing thoughts
 - d. Excessive sleepiness
10. James ingested an unknown food and became pale and hoarse without signs of difficulty breathing. How quickly should you monitor and/or give treatment?
 - a. Immediately
 - b. Monitor and treat in 1 hour
 - c. Monitor and treat in 4 hours
 - d. Monitor and treat only if symptoms progress

Thank you very much for completing this survey.

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