The Effects of School Staff Food Allergy Education in a Large Urban School District

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Objective: In this study, we examined program feasibility and evaluated change in staff food allergy knowledge using an online course, in-person trainings, or a combination of these in a large urban school district. **Methods:** We used online surveys to identify and gather data on target and control school staff. In Year 1, target school staff were mandated to take online training with optional in-person training; in Year 2, all staff were mandated to take online training and target school staff received additional in-person training. Changes in food allergy knowledge, epinephrine availability, and reaction recognition were measured between groups and years. **Results:** Mandatory online training improved course completion among school staff members. Pre- and post-test scores demonstrated increased food allergy knowledge in those completing the online training course. The school-based food allergy awareness program led to heightened reaction recognition and treatment in target schools that received in-person education. Target school reactions were more appropriately treated than in controls. **Conclusions:** Online training is a feasible and effective tool for food allergy awareness, but in-person skills training may help prepare staff. The heightened reaction recognition and treatment in target schools reflects improved awareness and anaphylaxis preparedness.

Key words: food allergy; anaphylaxis; online training; school health; urban schools
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Food allergies are a major public health concern in the United States (US), accounting for nearly $24.8 billion/year in direct (healthcare and medical system) and indirect (family) expenditures.[1] Research shows that approximately 32 million people in the US. have food allergies.[2,3] Survey data suggest that 11% of American adults and 7.6% of American children have food allergies.[2,3] The US Centers for Disease Control and Prevention reports that during 1997-1999 and 2009-2011, food allergy prevalence among children increased by 50%.[4] African-American children, children residing in urban centers, boys, and children from families with incomes < $50,000 were more likely to have food allergies compared to their counterparts (ie, non-Hispanic white children, children in rural communities, girls, and children in families making > $50,000/year).[3,5-7] The most common allergens are peanuts, milk, shellfish, and tree nuts. [2,3] Additionally, childhood food allergies have shown to impair

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Figure 1
School Food Allergy Prevalence and Epinephrine Availability Survey for HISD School Nurses (Administered Annually for This Study)

1. What is the name of your school?
2. How many students do you have with a diagnosed life-threatening food allergy?
3. How many students with life-threatening food allergies have epinephrine at school?
4. How many pens are twin packs (2 doses)?
5. Has a student in your school had a food allergy reaction at school during this school year that required the use of epinephrine?
6. How many students with food allergies at your school required 911 activation this school year?
7. How many food allergy reactions received diphenhydramine only?
8. How many students have had a food allergy reaction this school year but did not require diphenhydramine or epinephrine?
9. Of the top 8 food allergens (eggs, milk, peanut, tree nuts, soy, wheat, fish, and shellfish), which is the most common allergen at your school?

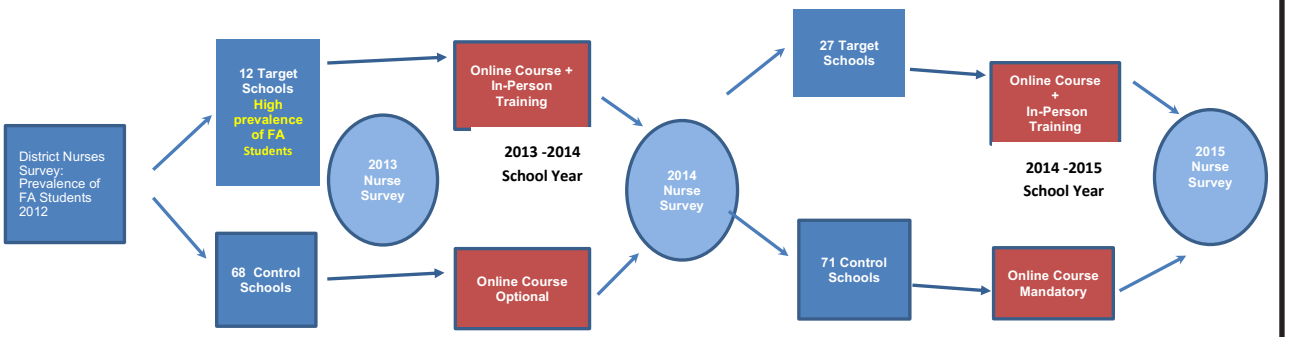
quality of life.[8-13] Children with food allergies are prone to experience food-related and target-related anxiety as well as bullying from their peers.[8-13]

More than 40% of children with food allergies have experienced severe allergic reactions such as anaphylaxis with 25% occurring in schools among children without a previous diagnosis. If left untreated, death may occur.[14-16] In fact, Bock et al[17] reported 32 individuals who died from food induced anaphylaxis in 2001. In addition, 31 individuals with fatal food anaphylaxis were identified between 2001 and 2006, and the reactions occurred in schools, homes, work/office settings, and camps.[18]

Because most cases of anaphylaxis are managed in the emergency department, strict avoidance and prompt administration of epinephrine is crucial for successful treatment and management.[14,15,18-23] Recent fatal school anaphylaxis cases in Texas prompted the passage of the Cameron Espinosa Act (SB 66) which allows stocking undesignated epinephrine auto-injectors in Texas schools with legal liability protection provided to those involved.[24] Texas was prompted to pass this bill because disparities in the availability of epinephrine in schools have been documented in schools within large urban districts.[25] Also, with legislation for management of anaphylaxis, schools have shown greater efforts to support students at risk for anaphylaxis compared to non-legislated environments.[26] In light of these developments, a widely implemented school-based food allergy intervention program was needed to enable staff to appropriately recognize and treat allergic reactions to enhance schools' safety.

Our overarching aim was to implement and evaluate food allergy training for school staff. In this study, we (1) compared staff knowledge of food allergy anaphylaxis at baseline, (2) evaluated the change in food allergy knowledge using an online course (Allergy Ready), in-person educational trainings, or a combination of these among Houston Independent School District (HISD) staff, (3) determined the change in epinephrine availability, and recognition and treatment of reactions after training, (4) determined the feasibility of training HISD staff using the online course alone; and (5) ascertained the barriers to online training in this population. We hypothesized this study would increase food allergy awareness, access to epinephrine, and correct treatment of food allergies in schools by offering tools to educate large populations of non-physician care providers and staff. We hoped to find that online training would be a feasible option for school staff, but we realized that through implementation, barriers to effective staff training would be revealed.

Figure 2
Schematic of Study Design - Houston Independent School District (HISD)



Note.
Nurses were surveyed for prevalence of food allergic students in schools. Target schools were trained in 2 school years with online and in person training sessions and compared to control schools who only received online training.

METHODS

In 2015, HISD consisted of an ethnically and socioeconomically diverse population of ~215,000 students within the greater Houston area (283 schools).[27,28] Of those, 10 were early childhood facilities, 153 elementary schools, 37 middle schools, 40 high schools, and the remaining 43 combined schools.[27,28] The majority (75.5%) of students were economically disadvantaged, as defined by qualifying for school lunch programs.[27,28] Texas Children's Hospital Food Allergy Program collaborated with HISD in 2010 to implement an educational food allergy program.

Instrumentation

To initiate the HISD intervention, nurses were surveyed online to determine food allergy prevalence in their students in spring 2012 (Figure 1). The same questionnaire was used in May 2013 and May 2014 to determine the assigned epinephrine availability (number of epinephrine auto-injectors per food allergic child), and the food allergic reaction rate (number of reactions per food allergic child) at baseline prior to and after the intervention. Questions included: (1) the number of food-allergic students, (2) the number of epinephrine auto-injectors available on the campus, (3) the number of reactions during the preceding school year, and (4) the most common allergen reported. Additionally, after May 2015, barriers to online training were obtained from school staff participants (Figure 2). A 7-item knowledge test was administered before and after completion of Allergy Ready to determine change in food allergy knowledge from baseline. The percentage of correct answers were compared pre- and post-intervention.

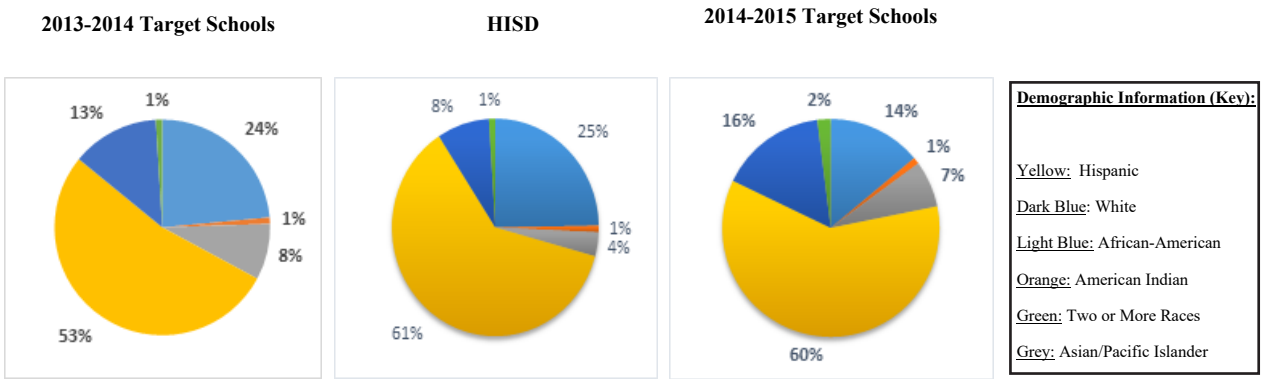
Allergy Ready CARE Course

Allergy Ready is a free, interactive online course, developed by Food Allergy Canada, the Canadian Society of Allergy and Clinical Immunology, Leap Learning, and Food Allergy Research & Education; one accesses it at: www.allergyready.com. This course is designed to educate school staff by providing a comprehensive tutorial on managing food allergies and anaphylaxis in the school setting. The goal of the course is to help school staff to C.A.R.E: (1) Comprehend the basic facts about food allergens, (2) Avoid the allergen, 3) Recognize the symptoms of a reaction, and (4) Enact an emergency protocol. Questions in the validated pre- and post-tests embedded within this course assess knowledge of the symptoms of food allergy reaction and proper treatment in multiple choice scenario based questions.[29]

Target School In-person Trainings

In addition to completing online training, schools that were designated as the intervention group (referred throughout this manuscript as "target schools") held 1-3 hour annual on-campus train-

Figure 3
Demographic Information for Target Schools and HISD as a Whole



ings for teachers, administrators, and staff (Figure 3). This was done by the school nurse. Some nurses also held follow-up trainings with food allergic students in their classrooms. The district-wide food allergy nurse educator assisted and supported the on-campus trainings.

Sampling

Year 1 school participation included schools with: (1) $\geq$6 food allergic students in an elementary campus, (2) presence of a school nurse part-time, and (3) agreement of both the principal and nurse to hold in-person trainings about food allergies. For Year 2, elementary, middle, and high school campuses could participate if they met criteria 2 and 3.

Procedure

In Year 1 (2013-2014), 12 elementary schools participated as target schools and 68 elementary schools with survey results served as controls and in Year 2 (2014-2015), 27 elementary, middle, and high schools participated, and 71 HISD schools, for which we had survey results, served as controls. In Year 2 we added 15 new target schools. During Year 1, target schools were mandated to take online training while the remaining control schools were given the option to take online training. Target school nurses were required to hold at least one in-person food allergy training for all school staff. For control schools, online training was not mandated, and no in-person trainings were held. Pre- and post-test scores were compared to determine if staff knowledge changed from school staff baseline knowledge. At the end of Year 1, surveys were again distributed to all HISD nurses to determine changes that had occurred in epinephrine availability and reactions during that school year. During Year 2, 27 elementary, middle, and high schools comprised the target school population while 71 HISD schools were in the control group. Both target and control schools in Year 2 were required to take the online course and target schools were required to provide in-person trainings. After the online component of the intervention, pre- and post-test scores were obtained, and the change in knowledge measured. Once Year 2 concluded, a survey to determine changes in epinephrine availability and food allergy reactions was distributed once again in addition to a new survey about barriers to online training.

Data Analysis

We aimed to measure several endpoints between groups (target vs control) and years. Ratios of (1) epinephrine availability, (2) food allergy reaction rate, (3) number of diphenhydramine-treated reactions over total reactions, and (4) number of untreated reactions over total reactions were compared before and after intervention. We used the Wilcoxon signed-rank test to compare the same schools between years. However, for comparisons between target and control schools, the Wilcoxon rank sum test was used. Because 15 new target schools were added in Year 2, the differences between Year 1 and Year 2 were analyzed as follows: schools were

Table 1
Staff Taking Online Training for 2013-2014 and 2014-2015

School-based Staff (N = 18,269)	Staff-initiated Online Training	Online Training Complete	Number of Target Schools	Target School Staff Trained	Control School Staff Trained
Total	10,489 (57.4%)	5233 (28.6%)	N/A	519 (2.8%)	4714 (25.8%)
2013-2014	2871 (15.7%)	1212 (6.6%)	12	94	1118
2014-2015	7618 (41.7%)	4021 (22%)	27	425	3596

grouped into those that were target in Year 1 (Target: Year 1), schools that were target in Year 2 regardless of their status in Year I (Target: Year 2), schools that were target in both years (Target: Year 1 & 2), and schools that were target in Year 2 but control in Year 1 (Target Year 2; Control: Year 1).

For Year 2, 27 target schools were selected and given additional in-person training, whereas, 71 schools served as controls. Using Pearson's Chi-Square test, the number of school employees who completed online training in both years were compared to determine the barriers to online training. The mean and standard deviation were used to summarize the pre-intervention and post-intervention online course score data for the target and control schools for each school year. The difference in food allergy knowledge between years and between target and control schools were compared using the t-test and pre-test and post-test scores were compared using the paired t-test. We used STATA version 12 for the analysis.

RESULTS

The target school populations for both Years 1 and 2 were demographically similar to that of HISD as a whole. There was a comparable mix of ethnic diversity. All 12-target schools from Year 1 participated as target schools in Year 2, and although we had a 100% response rate for all 3 annual surveys from those 12 schools, only 18 out of 27 target schools in Year 2 responded to the post-intervention survey.

Completion of Online Training

Table 1 shows that out of the 18,269 school staff who had access to the online training, 10,489 (57.4%) school staff initiated the online training with only 5233 (28.6%) completing it from 2013 to 2015. Out of 2871 (15.7%) school staff who initiated the online training in Year 1, only 1212 (6.6%) completed the program. In Year 2, out of 7618 (41.7%) school staff who initiated the online training, only 4021 (22%) completed it. Mandating online training for both target and control schools increased initiation and completion rates ($p < .05$), but overall staff training numbers were still low, with only 28.6% (5233/18,269) of HISD staff trained. Only 94 target school staff completed the online course for Year 1, and only 425 completed it in Year 2, whereas 1118 control school staff completed the course during Year 1 and 3596 during Year 2. Overall, the completion rates for the online training were higher in the Year 2 than in the Year 1; additionally, the rates were higher among control school staff members than among the target school staff members. Most of the HISD staff (71.3%) did not take Allergy Ready. Out of the school staff who took online training, 25.8% were from control schools, and only 2.8% were from target schools.

Online Training Efficacy

Table 2 shows online test scores for Year 1 and Year 2 and illustrates that the post-test scores were significantly higher than the pre-test scores for both the target schools and control schools in both years. Thus, the training program was effective for increasing knowledge in both years for those who actually took the training, but it was relatively more effective in the Year 1 as compared to Year 2 ($p < .001$). The post-test scores in Year 1 were higher than the post-test scores in Year 2, whereas the pre-test scores for Year 2 were higher than the pre-test scores for Year 1 ($p < .001$).

Perceived Efficacy

After Year 2, we surveyed all 260 HISD school

Table 2
Allergy Care Course Online Staff Test Results for 2013-2014 and 2014-2015

Source	N	Pre-test Score Mean % (SD)	N	Post-test Score Mean % (SD)	Test Score Differences	p-value
2013-2014 Year I						
Control	518	59.3 (30.2)	431	91.8 (64.6)	32.1 (3.4)	< .001
Target	56	73.2 (26.8)	56	91.7 (13.1)	18.4 (3.4)	< .001
All	574	60.7 (30.2)	487	91.8 (60.9)	30.6 (3.1)	< .001
p-value: Control versus Target		0.0010		0.9911		
2014-2015 Year 2						
Control	717	68.5 (27.8)	801	87.5 (15.8)	18.8 (1.1)	< .001
Target	49	73.1 (25.7)	53	86.8	12.6(4.1)	.0036
All	766	68.8 (27.7)	854	87.4	18.4 (1.1)	< .001
p-value: Control versus Target		0.2687		0.759		

nurses about their perceptions of the efficacy of the online program, which had been available for 2 years. The Food Allergy Training Survey had 91 respondents (35%) (Table 3), who voiced their ideas on barriers to the implementation and adoption of the online training intervention. Of the 91 responders, 35 nurses (38%) had taken the online course, 48 (54%) knew about the course but had not taken it, and 7 nurses (8%) reported that they had never heard of the course. Since food allergy training was delivered both online and in person at the target schools, the survey inquired about which type of training the respondents would prefer if food allergy training were implemented district-wide. In response, 44 (48%) nurses preferred a combination of both online and in-person training, 35 (38.5%) preferred only online training, and 13 (14.3%) preferred in-person training only.

Advantages of Online Training

Overall, 22 of the 35 nurses who preferred only online training did so because it provided good information. Three nurses preferred online training due to the ease of access, and one nurse preferred it due to participant paced progress, allowing the learner to take more time to absorb information.

Disadvantages of Online Training

Overall, 12 out of 91 nurses (13.2%) reported that the online course was time consuming, 2 did not know how to access the online program, and one nurse felt that scenario-related test questions were confusing. Three nurses felt that in-person training was also necessary because online training was "not as engaging as in-person." Some staff liked in-person training and did not want or need online training, and others felt "the need to check out epinephrine technique in person." Several nurses voiced that staff required at least supplemental in-person skill sessions and not only the online course.

Epinephrine Availability

The number of epinephrine auto-injectors per food allergic child was measured. Over the 2 years of the study, target schools had an overall 6% increase in availability and the control schools had a 4% decrease ($p = .22$). When comparing control school epinephrine availability in schools that converted to target schools in Year 2, there was a trend towards a larger increase in epinephrine availability in the target schools (16%; $p = .06$).

Reaction Recognition and Treatment

When comparing years 2014 and 2015, there was a decrease in diphenhydramine-treated reactions among all schools: 85% in 2014 to 51% in 2015 ($p = .04$) and the control schools: 96% in 2014 to 46% in 2015 ($p = .02$). For the diphen-

Table 3
Survey Results: Barriers to Implementation of Online Training

Source	Number	Percentage
School nurse survey, 2015	260	100%
Total responses received	91/260	35%
Nurses who took the course	35/91	38%
Nurses who had never heard of the course	7/91	8%
Prefer both in-person and online training	44/91	48%
Prefer online training	35/91	38.5%
Prefer in-person training	13/91	14.3%
Advantages of Online Training		
Reported good information	22/91	24.2%
Ease of access	3/91	3.3%
Participant paced	1/91	1.10%
Disadvantages of Online Training		
Takes too long	12/91	13.2%
Did not know how to access	2/91	2.2%
Cannot ask questions directly	1/91	1.10%
In-person better / Still necessary in addition to online	3/91	3.30%

hydramine treatment for reactions among schools with at least one reaction, the control schools had more diphenhydramine-treated reactions than the target schools in all years with Year 2 showing a statistically significant difference. (p = .003).

The total untreated reactions per total reactions for the target school decreased from 29% at baseline to 17% in Year 2 and stayed the same at 18% by the end of Year 2. Untreated reactions decreased for the control schools from 52% at baseline to 33% in Year 2 and then rose again to 48% at the end of Year 2. Untreated/total reactions increased from 2014 to 2015 for control schools (p = .03). The rate of untreated reactions trended towards being higher among the control schools than the target schools in all years and approached significance in 2015 (p = .06).

Reactions per food allergy child increased 2.5 % in target schools and decreased 2% in control schools when comparing Year 1 and Year 2. When comparing the beginning and end of Year 2, reactions per food allergy child increased for both targets (8%) and control schools (18%). For the beginning of Year 2, the reactions per food allergy child trended towards being higher among the target schools compared to the control schools (p = .07). None of the changes in reaction recognition were statistically significant.

The overall recognized reaction rate was similar for all schools from year to year with an non-significant decline from 20% to 10%, (p = .94) in Year 1. The reaction rate in Year 2 of the study for all schools was a total of 25% and was similar to Year 1 (p = .12). The reaction rates for the target schools increased over the study period, from 7.4% at baseline to 9.9% in 2014 and 22% in 2015. The overall reaction rates for the control schools decreased from 23% at baseline to 9.7% in 2014 and then increased to 26% in 2015.

DISCUSSION

The educational intervention conducted in this study tested the feasibility of training school staff on food allergy and anaphylaxis using an online training program. We compared the availability of online training to in-person education carried out at target schools and determined their impact on epinephrine availability and staff knowledge. In addition, the data gathered during the study period helped to ascertain the barriers to online food allergy training. The online food allergy education was feasible for school staff, and mandatory online food allergy education more than tripled completion among school staff. This food allergy awareness program implemented in HISD led to heightened reaction recognition and treatment in target schools that received additional in-person education. Our results supported prior studies that assessed the impact, and feasibility of online anaphylaxis training for school personnel.[29-31]

The main barriers cited by school staff preventing completion of online food allergy training were time constraints and the perception that in-person training was enough. The course took more than 2 hours to complete, and thus, school staff initiated online training but, at times, failed to complete it. During Year 1 of the study, 2871 teachers, nurses, and administrators-initiated Allergy Ready, but only 1212 completed the course (42.2%). On the other hand, in Year 2, 7681 teachers, administrators, and nurses initiated the course, and 4021 completed it (52.3%). Mandating Allergy Ready for both target and control schools in Year 2 increased initiation and completion rates ($p < .05$), but overall staff training numbers were still low, with only 28% (5233/18,269) of HISD staff trained.

Because participation in the target school cohort was voluntary when offered to HISD schools with > 6 food-allergic students, and it depended on the school nurse and principal agreement to launch in-person food allergy education for the staff on campus, there was a natural tendency toward selection bias, as the schools that participated were essentially self-selected. It may follow that schools whose administration felt they were able to handle implementation of the program had more perceived or actual resources and parent support; therefore, the target schools would have essentially been a convenience sample. This may also be why the target schools' demographics, including the percentage of minority students and those on school lunch, differed somewhat from those of HISD as a whole.

Though there seemed to be an increase in epinephrine availability in Year 2, this was not statistically significant, and fluctuations in epinephrine availability could be due to the increased number of target schools in Year 2. The control group membership was more constant year to year, and there were only minor fluctuations in epinephrine availability in controls schools, which were also not significant.

Further bias was likely introduced because we first confined target school participation of our pilot project to elementary schools based on need, since most first diagnoses of food allergy occur in the elementary age group < 12 years old.[2,3,32] This, in combination with the fact that the target schools represented < 10% of the HISD population, is likely why there were slight differences in demographic and socioeconomic distribution between the target school populations and HISD as a whole.

Despite these caveats, the target school populations were still diverse ethnically and economically, and as we expanded the target school program to middle and high schools, the demographic and socioeconomic characteristics of the target school population closely represented those of the district as a whole. Although less than 10% of total HISD population was represented in the target schools, they were likely still a representative sample based on diversity.

An additional limitation found in the study was the fact that we could not ascertain information about the specific individuals who completed the training and those that did not complete the training for both online and in-person. Because of this, we could not measure the differences between in-person and online participations as well as pre- and post-tests for in-person training. Data were not collected to determine if the online course training was conducted first or the in person training for the target schools.

The trend toward higher reaction rates and treatment rates seen in target schools after the intervention in Year 1 was initiated may indicate that the staff at these schools were more vigilant about food allergies because the school culture was focused on this issue and they were more likely to recognize a food allergic reaction. Those trained were also more

likely to treat students appropriately after recognizing a reaction, so fewer untreated reactions were reported. This may indicate that more appropriate action is taken if more food allergy education is delivered, and that an online educational model may still need supplementation and skills reinforcement with in-person training for food allergic reactions to be appropriately treated. For Year 2, reactions that trended up in both groups may reflect a rise in awareness after overall increase in online training throughout the district with mandated Allergy Ready Course.

Confounding Factors

Because the district saw a rise in epinephrine availability throughout the study period, it was difficult to establish significant differences in the epinephrine availability among target and control schools. It is important to note that there was a dramatic change in the school district's culture surrounding food allergy during the study period as a result of the collaboration between the authors, HISD, and regional nurse trainings. A food allergy nurse specialist was hired, and she served the whole district from an education and support perspective during the study period. Hence, there was generally more access to food allergy knowledge and more emphasis on food allergy safety across the board. Furthermore, even in Year 1, while the staff at target schools received food allergy training from school nurses and were mandated to take the online training, the remaining control schools still had access to the online course. Those with interest in food allergy who saw the course as part of their training likely self-selected to take it, and their knowledge and on-campus advocacy may have led to increased awareness and movement toward epinephrine availability. Because many of the control school staff elected to take the online course in Year 1, this created a confounding situation as knowledge rose in those control schools as well, which may explain why epinephrine availability also increased in control schools as well as target schools for both academic years.

Conclusion

The online food allergy education was feasible for the HISD staff, and mandatory online food allergy education more than tripled completion among school staff. This food allergy awareness program implemented in HISD led to heightened reaction recognition and treatment in target schools that received in-person education. Yet, although the Allergy Ready Course is comprehensive, it was not optimal for school staff training in this large US school district due to required time commitment. Target school staff receiving in-person training also often found it unnecessary to complete online training even though it was mandatory, while nurses felt the combination of online training with an in-person skills check would result in the most optimally trained staff to act quickly to prevent accidental exposure and to treat food allergic reactions. Future research will involve increasing compliance with an online educational tool by using a course requiring 30 minutes or less to complete. Also, declaring a training program mandatory without adding consequences for failure to complete the training will result in incomplete uptake of the training tool.

IMPLICATIONS FOR HEALTH BEHAVIOR OR POLICY

One of the *Healthy People 2020* objectives is to reduce severe food allergic reactions to food among adults. This begins by addressing childhood food allergies in places such as schools as a model for education in the adult population. Online food allergy education is feasible and leads to improved food allergy knowledge as evidenced by the results of this study. Even though training is required, barriers to effective training should be mitigated to positively impact health and safety. Additionally, school staff should be provided with resources and training because this will increase the awareness, and decrease adverse health outcomes by reducing the comorbidities and associated health care-costs. Therefore, we recommend continued online training supplemented by in-person training for people with food allergies.

Human Subjects Approval Statement

IRB approval was obtained prior to conducting this community-based public health quality improvement project. (IRB Approval # H-32167)

Conflict of Interest Disclosure Statement

There are no conflicts of interest to declare in this manuscript.

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