Original Article

Food Allergy Trends and Epinephrine Autoinjector Presence in Summer Camps

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What is already known on this topic? Epidemiologic data from summer camps are largely limited to injuries. An assessment of food allergies, asthma, and epinephrine autoinjector availability, to estimate risk, has not been performed in the summer camp environment.

What does this article add to our knowledge? It offers large population data on the incidence of food allergies and asthma in summer camp attendees across the United States and Canada. It also estimates the availability of prescribed epinephrine autoinjectors for food-allergic campers.

How does this study impact current management guidelines? This study establishes estimates of disease burden in camp settings and potential gaps in the availability of epinephrine for emergency use. These data could be used as a reference to strengthen camp policies and educational materials.

BACKGROUND: Pediatric campers with food allergies are at greater risk for exposure and anaphylaxis. A diagnosis of asthma increases risk for anaphylaxis. Epidemiological investigations of food-allergic children at high risk for allergic reactions requiring intervention in camp settings are lacking.
OBJECTIVE: The objectives of this study were to estimate the prevalence of food allergies among otherwise healthy campers in summer camps throughout the United States and Canada, and to assess asthma comorbidity and determine rates of epinephrine autoinjector prescriptions present in this population.
METHODS: We partnered with CampDoc.com, a web-based camp electronic health record system. Deidentified data were abstracted from 170 camps representing 122,424 campers. Only food allergies with a parental report of symptoms requiring intervention or with a camp prescription for an epinephrine autoinjector were included, whereas gluten, lactose intolerance, and food dyes were excluded. Asthma status and epinephrine presence on the camp medication list were assessed.
RESULTS: Overall, 2.5% of campers (n = 3055) had documented food allergies. Of these campers, 22% had multiple food allergies. Median age was 11 years; 52% were female. Nuts (81%), seafood (17.4%), egg (8.5%), fruit (8.1%), and seeds (7.2%) were the top 5 food allergies reported. Of food-allergic campers, 44.3% had concurrent asthma and 34.7% of those campers were taking multiple asthma medications. Less than half (39.7%) of food-allergic children brought an epinephrine autoinjector to the camp.
CONCLUSIONS: Life-saving epinephrine is not necessarily available for food-allergic children in camp settings. A substantial proportion of food-allergic campers are at higher risk for anaphylaxis based on concurrent asthma status. © 2016 American Academy of Allergy, Asthma & Immunology (J Allergy Clin Immunol Pract 2017;5:358-62)

Key words: *Pediatric; Summer camp; Allergy; Anaphylaxis; Asthma; Epinephrine autoinjector; Urgent care; Emergency care*

Childhood summer camp is a formative experience for the 11 million children who are estimated by the American Camp Association to attend summer camps yearly.[1,2] Summer camps provide children and adolescents an environment to learn independence away from home that will be necessary as they transition to high school and college. Summer camps do have a different supervisory environment compared with both home and school environments that may lead to an element of increased risk for illness or injury. Food allergies remain a life-threatening illness for children and adolescents in the form of anaphylaxis.[3-15] Food allergy rates in pediatric patients have increased significantly over the past 1 to 2 decades,[16-18] with current estimates of prevalence of food allergy ranging between 4% and 8% of children and adolescents.[16,18-20] Highly publicized pediatric cases of anaphylaxis-related death at summer camps have been reported in the past several years.[21-23] A previous study found that on college campuses, which share similar

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Abbreviations used
EHR- Electronic health record
ICS- Inhaled corticosteroid
LABA- Long-acting β-agonist
NHANES- National Health and Nutrition Examination Survey
SABA- Short-acting β-agonist

systemic and supervisory issues with summer camps, many young college students with food allergies were ill-prepared to deal with their food allergies and were at increased risk for anaphylaxis while on college campuses.[24]

Summer camps also give increased opportunities for food sharing and potential decreased supervision of meal times in comparison with home environments. Menus may vary substantially from home or school for each child and the risk of cross-contamination may be higher. In children studied in school environments who were administered epinephrine for symptoms of anaphylaxis, 24% had no prior history of food allergy.[11] Children with uncontrolled asthma and a diagnosis of food allergy are also at risk for more severe anaphylactic reactions.[4,6,7,13,25,26] In one study from 2010, a 5.2 times increased hazard ratio was reported for anaphylaxis in those patients with a diagnosis of asthma.[7]

Summer camps, unlike schools, are often located in remote locations without close proximity to emergency medical services. Children who experience an allergic reaction requiring intervention while attending camps in remote areas are at higher risk for delayed treatment or definitive care due to the lack of a nearby pediatric capable medical center. Also, unlike school settings, summer camps are not necessarily included in current legislation to have stock unassigned prescriptions of injectable epinephrine available for treatment of anaphylaxis.[27,28] As of September 2016, 38 states have legislation allowing schools to stock unassigned epinephrine autoinjectors, whereas 11 states have laws requiring schools to stock epinephrine devices.[29] One state has pending legislation.[29] This advance is likely in response to the financial incentive provided by the School Access to Emergency Epinephrine Act that was signed into law by President Obama in November 2013.[30] No large-scale studies have assessed the true presence of epinephrine in schools since the passage of this legislation. Prior data have shown widely variable rates of epinephrine availability.[31-35]

School-based laws are not globally applicable to summer camps as many summer camps are either private or nonprofit in nature and receive little funding to cover health- and safety-related expenditures. However, given recent acknowledgment that camps and other recreational entities should be treated similarly to schools, there are now 23 states that have passed legislation to allow camps to have unassigned epinephrine autoinjectors.[27,28] A recent study of camps' compliance with health and safety recommendations reported epinephrine availability in 64% of its surveyed population; however, it was unclear whether these autoinjectors were prescribed or unassigned in nature.[36]

The epidemiology of food allergies among children attending summer camps, along with concurrent asthma status, is entirely unclear. On review of the current literature, summer camps are an entity that is unstudied on a large scale. The most significant research barrier appears to be the lack of available electronic data from a large number of summer camps. Our study, which is the first to attempt to study food allergies and anaphylaxis on a large scale among camps nationally, sought to overcome this barrier by partnering with a camp-specific electronic health record (EHR) system to directly extract deidentified data from a large pediatric population of campers without having to rely on data indirectly obtained from camp administration on the health trends of their campers.

Our primary objective was to estimate the prevalence of food allergies among otherwise healthy campers in a large number of summer camps throughout the United States and Canada. The secondary objectives were to assess the extent of asthma comorbidity to identify campers at higher risk for life-threatening allergic reactions, and to determine rates of epinephrine autoinjector prescriptions present in this population.

METHODS

We partnered with CampDoc.com, the largest web-based camp-specific EHR system that manages health forms, medications, allergies, illness, and injury tracking for more than 500 summer camps (as of 2016) in the United States and Canada. At the time of this study during the 2014 summer camp season, the CampDoc.com census was only 184 camps. Of those 184 camps, only 170 camps were collecting allergy data. These 170 camps were used in this study, representing 122,424 individual campers. Camps self-identified as resident (overnight) camps, day camps, or both. All available deidentified allergy and asthma data from 2014 camp attendees were retrospectively abstracted in October 2014 onto Microsoft Excel (2011) after parental input into the EHR system. Notably, when parents filled out this EHR form, free text boxes for both medications and food allergies were used exclusively. In addition to the option of complete free text entering of answers, these boxes also employed an autosuggest option, which had both a list of possible options that could be scrolled through and selected, and a filter function to limit the available list options for selection once typing was initiated.

Food allergies listed as gluten intolerance, lactose intolerance, and food dyes were excluded from our analysis. Only food allergies with either a parental report of a previous history of an allergic reaction requiring intervention or a camp prescription for an epinephrine autoinjector for food allergies were included. Camper food allergies were categorized and coded into 11 different categories based on parental data input: nuts (peanuts and tree nuts), meat, wheat, legumes, soy, dairy, seeds, fruits/vegetables, egg, seafood, and other. Despite the fact that they comprise 2 distinct categories of allergens, peanuts and tree nuts were categorized together due to many parents reporting the food allergen as simply "nuts." Similarly, "seafood" comprised both fish and shellfish and "seeds" encompassed both sesame and sunflower due to parental report. Campers' asthma status was also obtained using either parent report on the medical form and/or by camp documentation of asthma medications. Asthma medications were defined as inhaled corticosteroid (ICS), inhaled short-acting β-agonist (SABA), combination ICS/long-acting β-agonist (ICS/LABA), and leukotriene inhibitors. SAS 9.3 (SAS Institute Inc., Cary, NC) was used for statistical analysis. Data were summarized using descriptive statistics.

RESULTS

Overall, 2.5% of campers (n = 3055) from 167 US and 3 Canadian summer camps had documented food allergies. Of the US camps, 21.6% (n = 36) were located in the Midwest, 41.3%

TABLE I. Food allergen prevalence amongst campers

Food allergen	Percent* of food-allergic campers (n)
Nuts (peanuts, tree nuts)	80.95% (2470)
Seafood	17.84% (545)
Egg	8.5% (261)
Fruit/vegetable	8.1% (247)
Seeds	7.2% (219)
Dairy	6.0% (184)
Soy	2.0% (62)
Legumes	2.0% (62)
Wheat	1.4% (43)
Meat	0.9% (28)
Other†	0.5% (16)
Multiple‡	22.7% (692)

*Individual food allergy based on (n = 3055) campers with food allergies.
†Spices, chocolate.
‡Campers with >1 food allergy.

(n = 69) in the Northeast, 22.2% (n = 37) in the South, and 14.9% (n = 25) in the West according to the US Census Bureau categorization system. There were 111 resident (overnight) camps, 27 day camps, and 32 combination. Food-allergic campers had a median age of 11 years; 52% were female. Table I highlights 11 main camper food allergy categories. The highest rates of allergy were nuts, seafood, and eggs. Fruits/vegetables, seeds, and dairy were also seen with relatively high rates in comparison with the remaining categories of allergens. Of the campers with documented food allergies, 22% had multiple food allergies.

Only 39.6% of food-allergic children (n = 1211) brought a prescribed epinephrine autoinjector to the camp. Of the campers in our sample population with food allergies and asthma, 48.6% (658/1353) had epinephrine autoinjectors. In contrast, of the campers in our sample with food allergies only and without a diagnosis of asthma, 32.5% (553/1702) had epinephrine autoinjectors, $\chi^2 = P < .01$. In stratifying data by camp type, among resident (overnight) campers, 41.5% (659/1460) had an epinephrine autoinjector; among day campers, 23.9% (156/651) had an epinephrine autoinjector; and among campers from camps identified as both resident and day status, 41.9% (396/944) had an epinephrine autoinjector, $\chi^2 = P < .01$. Finally, separating out food-allergic campers in our population by region showed fairly similar rates of epinephrine autoinjector presence, with results of Canada 32.1% (18/56), Midwest 40.1% (149/371), Northeast 38.8% (638/1642), South 43.2% (336/776), West 33.3% (70/210), with a $\chi^2 = 0.05$.

Of campers with food allergies, 44.3% (n = 1353) also had a diagnosis of asthma. Of this group of food-allergic campers with asthma, 34.7% (n = 469) were documented as taking multiple asthma medications.

DISCUSSION

Our study using a summer camp-based EHR of 170 summer camps is the first to demonstrate that a substantial number of children in summer camps have a diagnosis of food allergies. The prevalence in our study at 2.5% of campers was lower than that seen in prior studies.[16,18-20] An explanation for this discrepancy from prior data may be self-selection bias within our study population. Our sample electively participates in camp attendance. It is possible that parents of children with food allergies avoid the camp setting entirely due to the environmental differences and increased risk factors discussed previously, not signing their children up for camp experiences, which could result in lower overall rates of food allergies in our cross-section of campers nationwide.

Rates of food allergy between genders in our population were similar, as expected.[19,20] Finally, allergens with the highest rate were combined peanuts and tree nuts, followed by seafood. This is different from most recent National Health and Nutrition Examination Survey (NHANES) data published in 2013, which showed milk in highest frequency, followed by the combination of peanuts and tree nuts.[20] The discrepancy may be accounted for by the nature of our sample population being of "camp age" and, thus, older than the general pediatric population represented in the NHANES study. Given that many children typically outgrow their milk or egg allergies before the age of 6, which is just when our summer camp population starts being measured, there may be an inherent bias toward peanuts, tree nuts, and shellfish allergy in our sample.

Arguments are raised regarding the true prevalence of food allergy, given that most research employs a model of self-reported data and when using comparative forms of diagnostics such as skin-prick testing, rates are discordant.[37] This is a limitation of our study and most other previous research studies on food allergy rates that are similarly complicated by misconception on the true definition of food allergy. For example, oral allergy syndrome symptoms with ingestion of fruits and vegetables are often misconstrued by the lay population as true food allergy, which possibly skews data in self-reporting-based study designs. However, given that large-scale studies with more invasive diagnostic testing are impractical, longitudinal self-reported survey data and resultant relevant trends are critical.

In our summer camp population, similar to other studies investigating food allergy prevalence, there was a high rate of comorbid asthma.[4,6,7,13,25] The rate of parent-reported asthma was 44.3% in our sample; however, in those campers, 34.7% had multiple asthma medications on their home medication list, which may suggest more severe or poorly controlled asthma. Children with exposure to food allergens with severe or uncontrolled asthma may have concomitant flare of their asthma symptoms. In these children, it may be important for camp medical personnel to consider using epinephrine earlier in the course of treatment. This high-risk population of campers with asthma and food allergies are a possible intervention point for focused emergency planning for camp directors when assigning meal plans, rooming accommodations, as well as when selecting and training counselors.

Most surprisingly, our results show that the majority of campers (approximately 60%) with food allergies did not bring a prescribed epinephrine autoinjector with them to camp. The potential impact of this finding is that a substantial number of children may be at risk for delayed treatment given that epinephrine is the main life-saving intervention for anaphylaxis. In an assessment of whether any factors influenced likelihood of having an epinephrine autoinjector present at camp, a promising finding was that children in our sample with comorbid asthma were more likely to have this medication prescribed, which may be reflective of awareness of their higher risk status. Also, attendance at a resident, overnight camp was found to be indicative of a higher likelihood of epinephrine presence on the medication list. In these instances, given that the camper receives

all meals at the camp location, there may be greater vigilance in ensuring prescription presence. Finally, the region of the camp location did not seem to affect likelihood of having an epinephrine prescription while at the camp. This result has interesting implications given the state-by-state difference in laws addressing "stock" epinephrine availability as discussed earlier. For those who did not have epinephrine on their medication list despite allergy diagnosis, further investigation is necessary to identify the barriers for carrying appropriate medications.

Currently, it is unclear to what extent summer camps have formal food allergy policies, training, and available stock unassigned prescriptions for epinephrine autoinjectors. Given our study finding that many campers with food allergies did not have available epinephrine, future legislation or national guidelines should strongly consider having stock unassigned epinephrine autoinjectors available for emergency use for any camper. Legislators and public health officials should also consider how to best financially support such legislation for summer camps because these private or not-for-profit camps, unlike public schools, do not receive state or federal funding. Further, formal training including hands-on training for epinephrine autoinjector administration would be prudent for all supervising staff, given that children may not have prior experience in administration themselves.

Previous barriers to large summer camp studies have been difficulty with enrollment, as well as dependence on camp administration or camp medical staff report of health trends, and the lack of electronic medical records.[36] Research was mainly limited to survey-based data, reliant on ample response rates. Given our method of anonymous chart extraction, response rate was not a problem. Similarly, our data were reported by parents, as surrogates for the children, reflecting the active medical record of each camper. Our team sees this as a significant advantage of this study technique.

Although our study demonstrates that collaboration with a camp EHR system allows for a large-scale study of campers with asthma and food allergies, there were several limitations. First, not all camps had food allergy data available; however, given that this is the largest study of food allergies in camp settings, we contend that it represents the most complete view of food allergies among summer camps available to date.

Second, food allergy prevalence assessment in our study was limited to parent-entered food allergies on the history and physical intake form, without laboratory confirmed diagnoses. This online form was filled out based on required precamp history and physical with the child's primary care physician. The authors acknowledge that this is not the gold standard form of diagnosis. However, the most recent large-scale studies to date utilized the survey-based study technique with self-reported allergy rates to estimate food allergy rates.[19,20] Self-reported allergies are also the standard by which hospitals and medical offices function during intake assessments to confirm allergies. These self-reported allergies dictate prescribed drugs and diets in these settings. More intensive approaches with appropriate diagnostic confirmation of allergy are expensive, time consuming, and unrealistic on a large scale such as ours.

Another large limitation was the lack of specificity regarding nut and tree nut allergies. The authors acknowledge that peanuts and tree nuts are different categories of allergens. Also, given that peanuts are a part of the legume family, the additional category in our results of "legume" is confusing. The categorization of allergies was limited by the parent-entered nature of our system, with an autosuggest list and free text options. In many cases, the free text entry was simple "nuts," which led the necessity of combining peanuts and tree nuts into the same categories. Our category of "legume" thus comprises legumes other than peanuts. Modifications in the future CampDoc.com intake forms may allow for greater specificity regarding food allergy data. Lastly, our data were restricted by their cross-sectional nature and did not trend allergy- or asthma-related events over the course of a camp stay.

Finally, our categorization of campers as having a diagnosis of asthma was based on either diagnosis presence on the medical problem list in the EHR or asthma medication presence including ICS, SABA, ICS/LABA, or leukotriene inhibitors. This may be limited, as leukotriene inhibitors are less specific to a diagnosis of asthma given that they can also be used to treat allergic rhinitis. Of the 264 campers who had leukotriene inhibitors on their medication lists, 211 (80%) also had a diagnosis of asthma entered into the camp EHR. It is possible that some of the remaining 20% of patients had symptoms only from allergic rhinitis; however, the majority did not.

Despite the limitations of this study, we were able to demonstrate that the novel use of an EHR such as CampDoc.com for rapid acquisition of large-scale, patient-reported data is simple and feasible. The study's limitations have also taught our team how to best utilize this EHR resource. We anticipate increasing the specificity of our data for extraction by adjustment of certain data intake parameters such as allergen categorization and medication documentation. Additionally, although the number of camps enrolled in CampDoc.com at the time of our study was 170, there has been an interval increase of enrollment to greater than 500 camps across the United States and Canada, potentially increasing sample size and catchment area for future data collection. An EHR system also allows for a mechanism to directly survey camp administration instead of relying on accruing email addresses lists from several different organizations. Additional survey data from camp administration will allow assessment of barriers, policies, and knowledge deficits to develop tailored training modules and other educational materials for food allergy management. Collaboration with an EHR is a potential resource for monitoring other pediatric health issues beyond food allergies and asthma, such as common camp-related injuries.

CONCLUSIONS

The use of a national camp-specific EHR system allows for large-scale summer camp research, revealing that thousands of children with food allergies attend camps nationally. Over one-third of these children are potentially at higher risk of anaphylaxis given their concurrent diagnosis of asthma. A substantial proportion of food-allergic campers did not have an epinephrine autoinjector with them at camp. Public health and lawmakers should continue to strongly consider making generic epinephrine autoinjectors available for emergency use at summer camps. Future interventions include use of a camp EHR to train and assist camp staff in rapidly identifying high-risk campers and food allergies, and to rapidly disseminate summer camp-specific anaphylaxis policies.

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