

The US Peanut and Tree Nut Allergy Registry: Characteristics of reactions in schools and day care

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Objective: Severe food-allergic reactions occur in schools, but the features have not been described.

Study design: Participants in the US Peanut and Tree Nut Allergy Registry (PAR) who indicated that their child experienced an allergic reaction in school or day care were randomly selected for a telephone interview conducted with a structured questionnaire.

Results: Of 4586 participants in the PAR, 750 (16%) indicated a reaction in school or day care, and 100 subjects or parental surrogates described 124 reactions to peanut (115) or tree nuts (9); 64% of the reactions occurred in day care or preschool, and the remainder in elementary school or higher grades. Reactions were reported from ingestion (60%), skin contact/possible ingestion (24%), and inhalation/possible skin contact or ingestion (16%). In the majority of reactions caused by inhalation, concomitant ingestion/skin contact could not be ruled out. Various foods caused reactions by ingestion, but peanut butter craft projects were commonly responsible for the skin contact (44%) or inhalation (41%) reactions. For 90% of reactions, medications were given (86% antihistamines, 28% epinephrine). Epinephrine was given in school by teachers in 4 cases, nurses in 7, and parents or others in the remainder. Treatment delays were attributed to delayed recognition of reactions, calling parents, not following emergency plans, and an unsuccessful attempt to administer epinephrine.

Conclusions: School personnel must be educated to recognize and treat food-allergic reactions. Awareness must be increased to avoid accidental exposures, including exposure from peanut butter craft projects. (J Pediatr 2001;138:560-5)

Food allergies affect 6% to 8% of children¹ and are among the common medical emergencies that must be addressed in the school setting.² Although allergic reactions to virtually any food can occur, reactions to peanut and tree nuts (eg, walnut, Brazil nut, cashew, hazel) are relevant to the school setting. First, these are common allergies that are usually not outgrown^{3,4}; we recently reported that 0.6% of children in the United States have peanut, tree nut, or both allergies.⁵ Further, accidental ingestion of these foods occurs at a high rate, with schools being a common location.^{6,7} Such school reactions are often severe⁶ and can be fatal. In a review of 6 fatal allergic reactions to foods in children and adolescents,⁸ 5 were caused by peanut or tree nut and 4 of these occurred in school. Despite the high prevalence and severity of these allergies and the high rate of accidental ingestion in schools, there have been no studies specifically addressing the clinical features of peanut and tree nut allergic reactions, or any food allergies, in the school setting.

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PAR National Peanut and Tree Nut Allergy Registry

We undertook the present study to better characterize the features of food-allergic reactions in the school setting. We have maintained a voluntary, self-reported registry of individuals who are allergic to peanut and tree nuts, the US Peanut and Tree Nut Allergy Registry.⁷ We have previously noted that among registrants in the PAR, initial reactions

were most likely to occur in the home (72%), whereas subsequent accidental exposures were more likely outside of the home with 16% in schools or day care. In the present study, a randomly selected group of registrants in the PAR database who experienced peanut, tree nut, or both allergic reactions in school or day-care settings were evaluated. A detailed questionnaire was administered by telephone to determine the characteristics of the reactions, the allergy history, and the responses of the school personnel and families to the allergic reactions.

METHODS

Subjects

At the time of this study, there were 4586 persons registered in the PAR database.⁷ Briefly, this is a database maintained in conjunction with the Food Allergy Network, Fairfax, Virginia, containing the results of surveys returned by individuals (or parental surrogates) with self-reported peanut or tree nut allergy. The registrants were recruited through membership in the Food Allergy Network (a lay organization that provides educational materials for individuals and families with food allergies) and through questionnaires given to patients by allergists. Registrants included in this study were randomly selected from among those who indicated that an allergic reaction to peanut or tree nut occurred in school. These registrants (parental surrogates) were interviewed for this study by telephone with a standard questionnaire (75 questions) to obtain more details about the reaction(s). Participants were asked to give information on reactions for which they recalled significant details (causal food, symptoms of the reaction, and schools' responses). Thus not every reaction was included in this study. Informed consent was obtained from all participants, and the study was approved by the Mount Sinai Institutional Review Board.

Table I. Characteristics of the study subjects (n = 100)

Age at time of reactions	Median, 4 y (mean 5 y, range 9 mo-19 y)
Sex	69 male, 31 female
Other atopic disorders	Asthma—44% Allergic rhinitis—40% Atopic dermatitis—41% Additional food allergy—41% Egg—15%, milk—10%, fish/shellfish—9% Physician confirmed in 95%
Peanut- or tree nut-specific IgE antibody	Tested in 85%, 100% positive
Physician evaluation of allergy	100% confirmed

Definition of Reaction Severity and Type

Reaction severity was graded as previously described⁹: severe—hypotension, or wheezing with evidence of hives or diarrhea/vomiting, or significant involvement of 3 organ systems; moderate—wheezing alone, or significant involvement of 2 organ systems; mild—significant skin or gastrointestinal symptoms alone or in combination with mild symptoms in other systems or any combination of mild symptoms. Symptoms considered to be “significant” include hives, hypotension, loss of consciousness, dyspnea, vomiting, diarrhea, throat tightness, coughing, and wheezing; symptoms considered mild include erythema, pruritus, conjunctivitis, abdominal pain, nasal congestion, itchy throat, and sneezing. Skin symptoms were defined as hives, edema, pruritus, atopic dermatitis, and conjunctivitis; respiratory symptoms were throat tightness, dyspnea, wheezing, chest tightness, coughing, and nasal congestion; and gastrointestinal symptoms were mouth/tongue pruritus, nausea, abdominal pain, vomiting, and diarrhea.

RESULTS

Subjects

Of the 4586 registrants in the PAR database, 750 (16%) had reported one or more allergic reactions to peanut or tree nut in school or day care. The registrants' mean age at the time of the

survey was 11.4 years (median, 8.8 years; range, 1.7-63.1 years). Six hundred twenty-one (84%) registrants reported one school reaction, 112 (15%) reported 2, and 10 (1%) reported ≥3 school reactions. These 750 registrants were ordered randomly and contacted serially to obtain 100 participants for further study. In total, 154 were contacted (34 did not return the call, and 20 did not qualify [eg, reaction occurred at camp or before school]).

Parental surrogates (n = 96) and 4 adult subjects described 124 school/day care reactions to peanut (n = 115) and tree nut (n = 9) (Table I). Among those in elementary school, 68% were attending public schools. There was a nurse on location for only 23% of reactions. For 25%, a school reaction was the first indication of peanut or tree nut allergy (mean age, 3 years; range, 6 months to 12 years). For those with previous reactions to peanut or tree nut, 32% had one previous reaction, 37% had 2, 11% had 3, and 20% had >3 prior reactions.

Route of Exposure and Causal Food

Reactions were reported from ingestion (60%), isolated skin contact (24%), and possible inhalation (16%). Specific questions were asked to determine the level of certainty for each type of exposure. For ingestions, 70% were witnessed directly by an adult, and the remainder were reported by the child to an adult. For skin contact, 75% were

Table II. Foods causing reactions by route of exposure (of 124 reactions)

	Percent
Ingestion	
Cookie or baked product	54
Candy	21
Sandwich	9
Food contaminated by a utensil used with peanut	7
Tolerated foods picked out from trail mix containing peanut/tree nuts	3
Chili with peanut	~1
Peanut itself	~1
Peanut icing	~1
Contaminated frozen yogurt	~1
Skin contact/possible ingestion	
Craft project with peanut (bird feeders)	46
Foods (cracker, sandwich, donut, etc)	39
Object contaminated with peanut (table, chair, wrappers, etc)	15
Inhalation contact/possible skin contact or ingestion	
Craft project with peanut (bird feeders)	41
Foods (cracker, sandwich)	41
Object contaminated with peanut (table, chair)	12
Peanut fondue	6

observed by an adult to have touched the food but not ingested it, 12% were assumed to have only touched the food, and the remainder were reported by the child. For 20 inhalation reactions, all but 2 were reported by a supervising adult to the parental surrogate. For 16 of the episodes, the possibility of skin contact or ingestion could not be ruled out. In the 4 episodes during which an adult was certain no ingestion or contact occurred, one reaction developed when a child was within a foot of a peanut butter fondue (eye symptoms, hives), two took place when the child was at a table where peanut butter bird feeders were being made (hives/hives and wheeze), and one occurred when the child was within 2 feet of 15 children eating peanut butter crackers (hives and wheeze).

The school supplied the food in 61% of the episodes; in 18% another student brought the food, and in 20% a parent brought the food into the school. In 24% of the cases, a special occasion such as a birthday party was being celebrated. Reactions occurred in classrooms (79%), lunchrooms (12%), and a

variety of other locations such as outdoors during recess, on a school trip, in a dorm room, and in a sorority house. The location was influenced by the age group affected; preschool and day care reactions occurred almost exclusively in the classroom, whereas 55% of elementary school reactions occurred in the classroom with 29% in the lunchroom. Table II shows examples of the causal foods in children experiencing an accidental exposure. In many cases, the causal food was known to contain peanut or tree nut but was mistakenly eaten (baked products). However, there were also examples of cross-contamination and hidden ingredients. Non-ingestion reactions were strongly associated with craft projects in which peanut butter was used. Three reactions occurred in schools with peanut bans.

Characteristics of Reactions and Treatments

Reactions occurred at a median of 1 minute after exposure (mean, 9.8 minutes; range, 1-60 minutes). The initial symptoms, severity of final reactions, and percent treated with epinephrine

are shown in Table III. Initial mouth symptoms (tingling, oral pruritus) were a common initial gastrointestinal symptom (20%). Initial respiratory symptoms caused by presumed inhalation reactions were primarily manifested as conjunctival injection and rhinitis (15%) or cough (10%). For 90% of the reactions, medications were given (86% received antihistamines, 28% epinephrine). In considering the subgroup who experienced their first reaction to peanut or tree nut in school, compared with previous reactors, there was a similar distribution of severity (46% mild, 35% moderate, 19% severe) and use of epinephrine (15%). Overall, 53% of the medications were given in the school building. Teachers gave epinephrine in 4 cases, nurses in 7, parents in 4, and other personnel (ambulance personnel, another parent) in the remainder; 11% received emergency department/physician care. Among patients with previously identified allergy requiring medicine in school (36 cases), a variety of reasons were given for not administering the medication: the reaction was not noticed initially, the parents were called to pick up the child, or the teacher was unable to activate epinephrine (one case in which the teacher did not know to remove the protective cap).

School Responses

The first adult to become aware of the reaction was a teacher (59%), parents at the time of after-school pick-up (32%), and cafeteria workers, bus operators, or school nurses in the remainder. Once the reaction was noted, the person who took charge of the situation was the teacher (55%), the parent (30%), school nurse (10%), or other adult (eg, school secretary or cafeteria worker). Among school personnel taking charge of the situation, the most common action was to notify parents to find out what to do (60%). An emergency plan was in place for 33% of the reactions but was followed only 73% of the time. Epinephrine was available

Table III. Initial symptoms and final severity of reactions by exposure route (percent of 124 reactions)

Route	Initial symptoms				Severity			Received epinephrine (%)
	Skin (%)	Respiratory (%)	GI (%)	Unknown (%)	Mild (%)	Moderate (%)	Severe (%)	
Ingestion	32	15	37	16	39	36	25	36
Skin contact	90	3	0	7	61	16	23	13
Inhalation	60	25	0	15	55	28	17	22

GI, Gastrointestinal.

(29 episodes), but the technique of administration was never demonstrated to school personnel in 4 instances. Table IV summarizes the remedial actions taken after the reaction. Among the schools banning peanut, primarily classroom, rather than school-wide, bans were instituted.

DISCUSSION

The American Academy of Pediatrics,² the American Academy of Allergy Asthma and Immunology,¹⁰ and a number of health care experts¹¹⁻¹³ have addressed the need for emergency preparedness in the school setting. However, there have been no previous studies to evaluate features of the food-allergic reactions in schools. Because peanut and tree nut are common causes of food-allergic reactions in schools,^{5,7,8} we used the PAR to gain further insight into this gap in our knowledge.

A disproportionate fraction of reactions (64%) occurred in preschool or day care, and the school reaction represented the first reaction for 25% of the children (primarily those <4 years of age). Previous studies have shown that children often react to foods on first known exposure,⁶ that those with an atopic disposition are at particular risk for food-allergic reactions,^{6,14} and that asthma may be a risk factor for severe reactions.^{8,15} Pediatricians, parents, and caregivers should keep these issues in mind when considering the introduction of new foods in the school setting.

Table IV. Remedial actions taken by parents/schools after reactions

Response	Percent
Parents educated school staff about allergy	81
Medications/emergency plan instituted	41
Meals prepared at home	41
Banned food (from class or school)	16
"Allergy-free" dining table	15
Schools modified meal procedures (cleanup, sharing)	14
Students educated about food allergy	12
Modified procedures about school craft projects	4
No changes	5
Medical identification bracelet	2
Changed schools	2
Home schooled	2

The high rate of accidental exposure caused by baked products and shared foods, especially during special occasions, underscores the importance of supervision for the allergic child, including careful label reading. Small doses of peanut can elicit reactions,¹⁶⁻¹⁸ and indeed, reactions from shared utensils or contaminated foods were noted. These nuances (cross-contamination, label reading) must be part of the education process for caregivers.

Reactions occurred from skin contact with peanut in 24%; the majority of these reactions were caused by exposure to peanut butter in craft projects (bird feeders) and were not severe. Although the nature of self-reporting precludes the possibility of ruling out concomitant ingestion in at least some cases, these results show the importance of reducing possible contact by cleaning areas where food is eaten,

hand washing, close supervision, and excluding craft/science projects in which causal foods are used.

Inhalation was the reported mode of exposure for a minority of reactions (16%), but concomitant skin contact or ingestion was not definitively ruled out. Allergic reactions from inhalation of airborne food particles have been previously described in a variety of circumstances, most of which involve active cooking or processing of the food.^{9,19-22} The vast majority of children with peanut allergy were in classroom situations when peanut butter was served in the usual amounts and fashion without experiencing reactions. Thus it seems that most children with peanut allergy do not have reactions from typical room exposure to peanut, but high level exposure (craft projects, cooking) may pose a risk to some.

A majority of the reactions from ingestion began with gastrointestinal symptoms. A previous study of severe and fatal food-allergic reactions in children⁸ demonstrated that those with fatal reactions were more likely than those with severe, non-fatal reactions to experience symptoms without skin involvement. In 32% of cases in the present study, the reaction was not appreciated by school personnel. These findings illustrate the importance of educating caregivers about the full range of symptoms of a reaction.

Two limitations of the study could potentially lead to overestimation of severity of school peanut/tree nut reactions. First, the PAR database is potentially enriched for patients with significant allergy. Second, a bias toward recollection of more severe reactions may have occurred. Although it is not possible to make generalizations about the "average" child with peanut/tree nut allergy from this study, it is clear that this is a potentially severe allergy worthy of attention in the school setting.

We have documented several sources of treatment delay: failure to recognize reactions, failure to follow emergency plans, calling parents instead of administering emergency medication, and inability to administer self-injectable epinephrine. Such delays have been associated with fatal outcomes in schools.⁸ These findings show the importance of developing and reviewing emergency plans for prompt, appropriate responses and for reviewing techniques for administering the medications.²³

The American Academy of Allergy, Asthma and Immunology recently published a position statement concerning anaphylaxis in schools.¹⁰ That document reviews a number of suggested interventions for schools (eg, meal supervision, no food sharing, hand washing, provision of safe substitutes, education of staff, emergency treatment protocols). The results of this study indicate that the suggested measures would have potentially reduced the rate of accidental reactions

demonstrated in this report; however, the efficacy of these suggestions awaits individual validation. Additional information about management of food allergies in the school setting is available from sources such as the Food Allergy Network, Fairfax, Virginia (800-929-4040, www.foodallergy.org).

A fraction of the schools banned peanut, a controversial response. Arguments for banning include the reduction of potential causal food from the environment. Arguments against banning include causing a false sense of security, the difficulty in truly eliminating peanut, the burden on unaffected families, legal ramifications, and "slippery slope" arguments because other foods that cause reactions (such as cow's milk and egg) would need to be banned. Our study did not specifically address the efficacy of bans, but several findings are notable. First, in 3 cases, accidents occurred because of poor education despite bans. Second, the nature of virtually every reaction indicates that the interventions mentioned previously¹⁰ would have prevented reactions. There are currently insufficient data to draw specific conclusions about banning. Whether or not the food is banned, education about the allergy should be undertaken and emergency plans developed and reviewed frequently.

The results of this study support the notion that school personnel must be educated to recognize the signs of an allergic reaction, and a plan should be in place to treat symptoms promptly and appropriately, including intramuscular injection²⁴ of epinephrine. Awareness must be increased to avoid accidental exposures, including exposure from peanut butter craft projects. The child's physician, along with the family, can play a central role in the educational efforts needed to achieve a safe environment for the child.

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