
Allergic reactions to peanuts, tree nuts, and seeds aboard commercial airliners

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Background: Minimal data exist on the prevalence and characteristics of in-flight reactions to foods.

Objectives: To characterize reactions to foods experienced by passengers aboard commercial airplanes and to examine information about flying with a food allergy available from airlines.

Methods: Telephone questionnaires were administered to individuals in a peanut, tree nut, and seed allergy database who self-reported reactions aboard aircraft. Airlines were contacted to obtain information on food allergy policies.

Results: Forty-one of 471 individuals reported allergic reactions to food while on airplanes, including 4 reporting more than 1 reaction. Peanuts accounted for most of the reactions. Twenty-one individuals (51%) treated their reactions during flight. Only 12 individuals (29%) reported the reaction to a flight attendant. Six individuals went to an emergency department after landing, including 1 after a flight diversion. Airline personnel were notified of only 3 of these severe reactions. Comparison of information given to 3 different investigators by airline customer service representatives showed that inconsistencies regarding important information occurred, such as whether the airline regularly serves peanuts.

Conclusions: In this group of mainly adults with severe nut/seed allergy, approximately 9% reported experiencing an allergic reaction to food while on board an airplane. Some reactions were serious and potentially life-threatening. Individuals commonly did not inform airline personnel about their experiences. In addition, the quality of information about flying with food allergies available from customer service departments is highly variable and, in some cases, incomplete or inaccurate.

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INTRODUCTION

Accidental exposure to peanuts and tree nuts remains a serious problem for individuals allergic to these foods.¹ Severely food-allergic patients must be alert to situations in which exposure is possible and must be prepared to treat reactions when they occur. This is particularly important when the individual has little control over their surroundings or cannot seek medical attention, as when traveling by airplane. To characterize outcomes and behaviors in these situations, we present the details of 45 self-reported in-flight allergic reactions to food.

Issues surrounding airplane travel for food-allergic individuals have been previously examined. In 1999, the US Department of Transportation discussed requiring airlines to implement “peanut-free zones.” The proposal was not adopted owing to lack of scientific evidence that such a measure was needed and could be effective.² We now add data to the growing evidence^{3–8} that in-flight reactions to foods occur and can be life-threatening. The self-reported circumstances and characteristics of such reactions experienced by 41 food-allergic individuals are herein reported. Because food-allergic travelers are often advised to call an

airline to get more information about flying with a food allergy, we also sought to determine whether the information given to different callers was consistent and matched online information.

METHODS

Participants were recruited via advertisements in regional newspapers. A total of 471 individuals with convincing medical histories of immediate, IgE-mediated peanut, tree nut, or seed allergy were included. Population details will be reported elsewhere. The study was approved by the institutional review board at the University of California, Davis. Participants completed a questionnaire detailing their food allergy history. Although the first 130 respondents were not asked about reactions occurring on airplanes, some filled in “airplane” as the site of a reaction in response to the following questions: (1) “Have you ever had a reaction after touching the food?” and (2) “Please describe the last 2 reactions.” After the peanut-free zone was proposed by the Department of Transportation, participants were asked, “Have you ever had a reaction on an airplane?”

Individuals (or parents) who reported in-flight reactions were contacted again and interviewed further. Nineteen participants provided a blood sample, and specific IgE to the incriminated food was measured using ImmunoCAP (Phadia, Uppsala, Sweden). Samples were considered confirmatory if specific IgE levels were greater than 0.35 kU/L. Three participants provided medical records showing ImmunoCAP results.

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The symptom severity score of allergic reactions during flight was assigned by a physician by applying a rubric outlined by Sampson.⁹ The severity score of a reaction on ingestion of that food under nonairplane circumstances was also recorded. All symptoms were self-reported. Grade 1 refers to localized pruritus, flushing, urticaria, angioedema, or oral pruritus; grade 2, generalized urticaria, nasal congestion, or sneezing and nausea or emesis ($\times 1$); grade 3, repetitive vomiting, rhinorrhea, marked nasal congestion, a sensation of throat tightness, or throat pruritus; grade 4, diarrhea, hoarseness, wheezing, cyanosis, mild hypotension, or “light-headedness”; and grade 5, respiratory arrest, severe hypotension, or loss of consciousness. For inhalation reactions, the following similar grading system was used: ocular pruritus and periocular angioedema (grade 1), all degrees of rhinitis (grade 2), specific report of throat pruritus or tightness (grade 3), hoarseness or wheezing (grade 4), and respiratory arrest, severe hypotension, or loss of consciousness (grade 5).

Airline information was gathered by 3 investigators (L.C.V., E.J.B., and S.D.) by calling the customer service number of each airline during August 2007. Airlines were considered to have information online if any of the following searches returned airline Web pages related to food allergy: (1) using the search engine *Google* to search airline name plus “peanut,” “allergy,” or “food” or (2) using the search function on an airline’s Web site to search for “peanut,” “allergy,” or “food.”

Statistical methods included multiple linear regression in the predictive model, with age as a continuous variable; sex, overall symptom severity grade (not on airplane), and airplane symptom severity grade to predict notification of flight attendant; and Pearson correlation to determine whether treating a reaction correlated with telling a flight attendant or with reaction symptom severity. Significance was set at $P < .05$.

RESULTS

Characteristics of Allergic Reactions During Flight

Of 471 individuals in the nut and seed allergy database, 45 reported reactions occurring on airplanes; 41 were successfully contacted again. Population characteristics are summarized in Table 1. More than 80% of the participants had previously been treated for food allergy in an emergency department (ED), and 32% had been hospitalized. Although 80% of the participants had been given a recommendation to obtain a prescription for self-injectable epinephrine, only 63% stated that they regularly carry epinephrine. Thirty-seven percent of the participants had previously used self-injectable epinephrine. In addition, 90% of the participants had reported previous reactions to the food that were grade 4 (71%) or 5 (19%), indicating severe food allergy. The remaining 10% reported previous reactions to the food that were grade 1 (5%) or grade 3 (5%). Sixty-eight percent of the participants had a history of asthma.

During flight, most individuals (73%) experienced reactions to peanuts, followed by tree nuts (18%), sesame seeds

Table 1. Participant Characteristics

Characteristic	Participants, No. (%) (n = 41)
Female sex	19 (46)
Age at time of reaction, y	
2–7	6 (15)
8–17	3 (7)
18–29	7 (17)
30–49	16 (39)
≥ 50	9 (22)
Participants with >1 reaction on an airplane	4 (10)
Participants with peanut allergy	34 (83)
Participants with tree nut allergy	27 (66)
Participants with sesame allergy	7 (17)

(4.5%), and mixed nuts (4.5%). Incriminated tree nuts included walnuts (3 reactions), macadamias (2 reactions), cashews (1 reaction), pistachios (1 reaction), and unknown (1 reaction). Confirmatory ImmunoCAP data against the incriminated food was found for 19 participants (14 for peanuts and 5 for tree nuts).

Nearly 80% of reactions occurring during flight caused moderate-to-severe symptoms by self-report (grade 1, 9%; grade 2, 11%; grade 3, 22%; grade 4, 53%; and grade 5, 4%). Two reactions occurring on ingestion were grade 5, and both participants used self-injectable epinephrine. One participant (aged 74 years) had generalized urticaria, throat swelling, hoarse voice, and severe hypotension, and the other (aged 69 years) had generalized urticaria, throat swelling, hoarse voice, severe bronchospasm, and hypotension. Both participants required the supine position to regain or maintain consciousness, and the latter received intravenous fluids during flight with the aid of a physician. Both participants were met at the gate by paramedics, 1 after an emergency flight diversion to the closest airport.

All modes of exposure were reported as causes of in-flight reactions (Fig 1). Inhalation of airborne food particles was the most commonly reported mode of exposure. In many cases,

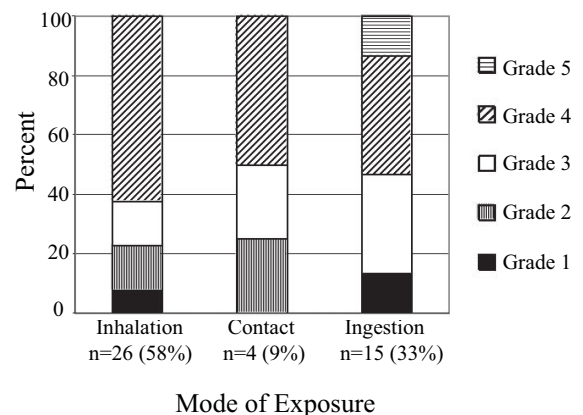


Figure 1. Modes of exposure by severity grade.

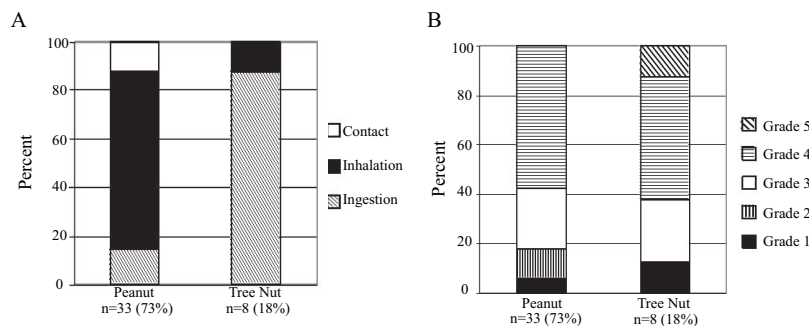


Figure 2. Modes of exposure (A) and reaction severity (B) in peanut or tree nut reactions (sesame excluded). Most tree nut exposures were via ingestion, and most peanut exposures were via aerosol (A).

reactions were reported to have started after peanuts were served and multiple bags were opened near the allergic passenger. Contact exposure to peanuts was reported by 4 participants (2 children and 2 adults). Inhalation and contact were more likely modes of exposure to peanuts than to tree nuts (Fig 2).

Although most participants reported moderate-to-severe symptoms, only 12 of 41 individuals (29%) told the flight attendant about a reaction. Only airplane symptom severity score predicted notification of a flight attendant ($P = .04$) (Fig 3). Even so, in 23 of 34 reactions with grade 3 or 4 symptoms, a flight attendant was not notified. Of 19 adults reporting exposure through inhalation, only 2 reported the reaction to flight personnel. One frequent flyer stated that he had experienced more than 40 in-flight reactions requiring β_2 -agonist use but had never notified flight personnel because the reactions were mild in his opinion (ocular symptoms, rhinitis, and wheezing) compared with those experienced on ingestion, which commonly led to ED visits. A Likert scale to score the self-perceived severity of a reaction was not administered, but several other adult participants also anecdotally commented that reactions caused by inhalation exposure while aboard the plane were mild compared with their usual reactions. However, because these participants reported the symptom of wheezing, these reactions were assigned a grade of 4.

Individuals who notified a flight attendant were more likely to treat the reaction during flight ($P = .02$). Treating a reaction during flight was also positively correlated with symptom severity ($P = .01$). Although 33 of 41 participants (80%) had been advised to carry self-injectable epinephrine, only 12 of 32 (38%) had epinephrine with them on the aircraft. During flight, 4 individuals (3 with ingestion and 1 with inhalation reactions) treated their reactions with self-injectable epinephrine (Table 2). All 4 of these participants visited the ED on landing. In contrast to the small number of individuals using self-injectable epinephrine, antihistamines were used by 71% of individuals who treated their reactions during flight.

Nearly half of the individuals who treated their reactions during flight continued treatment on deplaning, and 3 indi-

viduals began treatment after exiting the airplane (Table 2). Six individuals visited an ED, including the 4 who used self-injectable epinephrine during flight, 1 who used inhaled epinephrine during flight, and 1 who used a bronchodilator and antihistamines during flight. In addition, 2 individuals who had not treated their reactions during flight used self-injectable epinephrine on deplaning but did not proceed to an ED.

Of 25 participants who answered the question, "Have you subsequently changed the way you book flights to avoid a reaction?" 12 reported no change, 1 stopped flying, 6 fly only on airlines that do not serve peanuts, 2 will not eat food served by the airline, 2 communicate carefully with flight personnel, 1 wipes down the seating area, and another carries a mask to wear when peanuts are served. In addition, 1 individual pretreats himself with antihistamines and prednisone and brings a portable nebulizer on airlines that serve peanuts.

Airline Customer Service and Online Information

Customer service departments at 11 US-based air carriers gave information about their policies and procedures for addressing the needs of food-allergic passengers (Table 3). In only 17 of 55 possible instances did all 3 representatives from

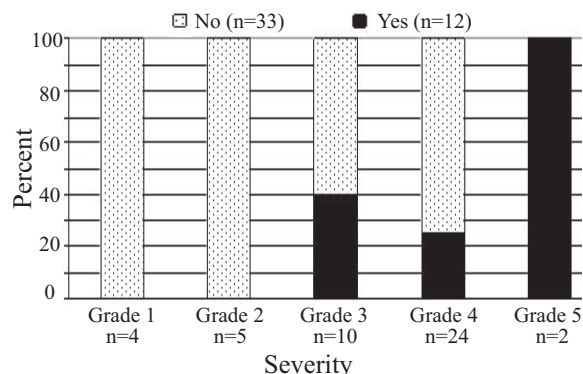


Figure 3. Notification of a flight attendant of an allergic reaction by symptom severity grade for 45 reactions in 41 individuals. The more severe the reaction, the more likely a flight attendant was notified.

Table 2. Treatment Responses to Allergic Reactions^a

Treatment	Participants, No. (%)
Treated reaction on plane	21 (51)
Injectable epinephrine	4 (19)
Inhaled epinephrine	2 (10)
Antihistamines	15 (71)
Albuterol	5 (24)
Treated reaction on ground	12 (29)
Also treated reaction on plane	9 (75)
Emergency department	6 (50)
Hospitalized	1 (8)
Injectable epinephrine	2 (17)
Antihistamines	3 (25)
Albuterol	1 (8)

^a Some individuals used more than 1 treatment.

a single airline answer a question consistently. Six of these instances were in response to the question, “Does your airline regularly serve peanuts?” and 5 were in response to the question, “Would you be willing to remove peanuts or tree nuts from a flight?” Despite the fact that the Code of Federal Regulations stipulates that any flight on which a flight attendant is required must carry an emergency medical kit containing antihistamine tablets, injectable antihistamines, and injectable epinephrine,¹⁰ 19 of 33 customer service representatives reported that their airplanes do not have kits containing epinephrine, and 18 of 33 reported that their airplanes do not have kits containing antihistamines. One representative reported that their flights do not carry emergency medical kits, and 10 customer service representatives from 9 carriers did not know whether their airplanes had emergency medical

kits with antihistamines or epinephrine. The quality of information about flying with food allergies available from customer service departments is highly variable and, in some cases, incomplete or inaccurate.

We also attempted to locate each airline’s food allergy policy online. Information about food allergy policies was found for 9 of the 11 airlines. Information ranged from single-sentence disclaimers about being unable to provide an allergen- and chemical-free flight to a full-page food allergy policy. Information gathered from Web pages was in agreement with that reported by a customer service representative via telephone in 65 of 99 instances (Table 3).

DISCUSSION

In this study, we present data from self-reported in-flight reactions to peanuts, tree nuts, or seeds. Of 471 participants in the original nut and seed allergy database, 9% reported reactions on airplanes. We found that some of these reactions were reported to cause moderate-to-severe symptoms, as determined using a previously published rubric,⁹ and most reactions were not reported to airline personnel.

To a large extent, these findings corroborate the findings of a 1999 survey by Sicherer et al.⁷ However, the present study includes more adults (78% vs approximately 7%), some of whom are business travelers who have had multiple reactions during flight. In addition, a slightly larger percentage of participants in this report experienced reactions that could be specifically attributed to tree nuts (18% vs 9.5%), and a larger percentage of participants reported reactions due to inhalation (57% vs 33%). Similar to the previous study, antihistamines were the most common treatment. In both studies, most

Table 3. Information Gathered From Customer Service Representatives at 11 US-Based Airlines

	Customer service representative No.	US-based airline										
		1	2	3	4	5	6	7	8	9	10	11
Information online	NA	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes
Disability complaints related to allergies, % ²⁰	NA	8	3	0	0.2	3	3	27	0.1	5	0.3	3
Medical kit containing epinephrine	1	No	Yes	UK	No	No	Yes	No	No	No	UK	UK
	2	No	No	No	No	No	UK	UK	No	No	Yes	Yes
	3	UK	UK	No	UK	No	No	No	No	UK	UK	No
Medical kit containing antihistamines	1	No	Yes	UK	No	No	No	No	No	Yes	UK	UK
	2	No	No	No	No	No	UK	UK	No	No	Yes	Yes
	3	UK	UK	No	UK	No	Yes	No	No	UK	UK	No
Regularly serves peanuts	1	No ^a	Yes ^a	No	Yes	Yes	No ^a	No	No	Yes	No ^a	No ^a
	2	UK ^a	No	No	Yes	Yes	No ^a	No	No	Yes	No ^a	No ^a
	3	No ^a	No	Yes ^a	Yes	No ^a	No ^a	No	Yes ^a	Yes	No ^a	No ^a
Serves products containing peanuts/tree nuts or made in a facility where tree nuts/peanuts are processed	1	Yes	Yes	Yes	Yes	Yes	Yes ^a	Yes	Yes	Yes	Yes	Yes
	2	UK ^a	Yes	No ^a	Yes	Yes	UK ^a	Yes	No ^a	UK ^a	Yes	UK ^a
	3	No ^a	Yes	Yes	UK ^a	Yes	UK ^a	Yes	Yes	Yes	No ^a	No ^a
Willing to remove peanut products from aircraft for flight	1	No ^a	No	No	No	Yes ^b	No	Yes	NA	Yes	NA	No
	2	Yes ^b	No	No	Yes ^a	Yes ^a	NA	Yes	NA	Yes	Yes	NA
	3	Yes ^a	No	No	No	Yes ^b	UK	Yes	Yes ^a	Yes	No	Yes ^a

Abbreviations: NA, not applicable; UK, unknown.

^a Disagrees with information given on the Web site.

^b Only in rows around allergic passengers.

participants did not notify flight attendants of the reaction, with 33% and 29% reporting reactions in the previous study and the present study, respectively.

There are several limitations to this study design. Participants were recruited via newspaper advertisements rather than being sequentially enrolled from a clinic setting. Participants were, thus, highly motivated and likely had more severe allergy than the general nut-allergic population, considering that 80% had been treated in an ED and 32% had been hospitalized. Because of the severe nature of participants' allergies, it is inappropriate to apply these results to all individuals allergic to tree nuts and peanuts. In addition, the data gathered relied on self-report. Self-reported data are subject to recall bias, intentional misreporting, and selective reporting. Self-report of reaction symptoms may have led to the inclusion of symptoms that increased the symptom severity grade of a reaction. However, strengthening these results, most participants were adults accustomed to living with severe food allergy, and most downplayed the reactions, although they reported wheezing as a symptom. Also, participants were not recruited specifically for airplane reactions, and 10 of the first 131 respondents indicated a reaction on an airplane before we added this question to the enrollment questionnaire.

We present a variety of self-reported inhalation and contact reactions. It is inherently difficult to determine the mode of exposure to an allergen, and it is possible that the true mode of exposure was incidental contact with mucous membranes or even accidental ingestion of the food. Although it is difficult to prove the involvement of aerosolized food particles, reported symptoms (wheezing and itchy eyes and nose) are consistent with symptoms elicited by other airborne allergens. In addition, other studies¹¹⁻¹⁵ support these data on the potential severity of inhalation and contact reactions in food-allergic individuals. Finally, although no Ara h 1, a major peanut allergen, could be detected in the air surrounding individuals eating or shelling peanuts,¹⁶ the fact that peanut proteins were found in the ventilation filters of commercial airliners demonstrates the presence of airborne peanut proteins on airplanes.¹⁷ It has also been shown that amounts as small as 100 μg of peanut protein can elicit subjective reactions.^{18,19}

Reactions reported to have resulted from ingestion reflect the ongoing problem of accidental ingestion of allergens from baked goods or foods prepared by others.¹ In several exposures, the nut was on an ingredient list but the individual did not read the list because the nut's presence was unexpected. In other cases, the nut or seed was in a sauce and no ingredient lists were readily available. In fact, 100% of the reactions by ingestion could have been avoided if the food-allergic passengers had carried their own food from home. These findings highlight the need for allergists to emphasize allergen avoidance when educating food-allergic patients.

Just over 50% of participants treated their reactions during flight. Most of them used antihistamines to treat reactions involving throat swelling and wheezing. Three passengers

would have used self-injectable epinephrine during flight but had forgotten to include this in their carry-on luggage. Two of these individuals did not notify a flight attendant about the reaction. Allergists should prepare their patients to handle such situations by working with them to create anaphylaxis emergency action plans.²⁰

Airline emergency medical kits, which can be used only by a certified medical professional, contain epinephrine, a β_2 -agonist multidose inhaler, and antihistamines. The potential benefit of these kits is demonstrated by participants who forgot their medication or required in-flight assistance. Accessing the emergency medical kit could minimize the number of untreated severe reactions with several caveats: (1) food-allergic individuals must notify flight personnel of the reaction, (2) flight personnel must be trained to effectively handle such situations, and (3) medical personnel must be present and volunteer to administer the appropriate medication. Administration of epinephrine could be facilitated if both doses of self-injectable epinephrine that are available were included in the kit rather than epinephrine in ampules.

In this study, flight attendants were not notified of reactions when symptoms were mild. Although an individual might perceive a reaction to be mild, there are reasons to report any reaction to a food while on an airplane. One reason is to increase the documentation and awareness that allergic reactions to food occur during flight. The most important reason is the safety of the allergic individual. Telling the flight attendant that a reaction is occurring allows preparation for the possibility of the reaction becoming more severe, and, according to these data, may increase the probability that the reaction will be treated during flight. The attendant can find a medical professional onboard who can access the emergency medical kit or help a passenger use his or her own medication.

Although flight attendants may be more familiar with an airline's procedures for supporting food-allergic passengers, customers should be able to gather accurate information from customer service representatives. This was not what we found. Although a single customer service representative may not accurately reflect an airline's overall ability to help food-allergic passengers, this method of information gathering was meant to mimic the situation a food-allergic customer might face when making a decision about which airline to fly. Appropriately, most representatives stressed the need to bring your own medication and the inability of airlines to provide peanut-free or nut-free flights. However, the variability in the information provided by representatives and on the Web page of a single airline indicates that it can be difficult for food-allergic travelers to find the information they need to plan a safe flight (Table 3).

According to the Americans With Disabilities Act, public entities and public accommodations must ensure that individuals with disabilities have full access to and equal enjoyment of all facilities, programs, goods, and services. A person, determined on a case-by-case basis, who experiences life-threatening reactions to food can be covered by the Ameri-

cans With Disabilities Act. However, few major domestic air carriers have policies protecting food-allergic individuals. In 2005, 322 complaints (2.6% of all) were filed against US air carriers on the basis of discrimination against individuals with allergies, inclusive of animal, food, and other allergies.²¹ Although individual airlines cannot be expected to regulate food brought aboard by nonallergic passengers, it is reasonable to expect the airline industry to provide accurate information to food-allergic travelers.

This study highlights several problems continuing to affect food-allergic individuals regardless of their physical location: lack of recognition of the life-threatening nature of some food hypersensitivities, the hidden presence of food allergens in unlikely places, and the failure of food-allergic individuals to carry or use emergency medications. All of these problems are magnified when in an enclosed space where resources for prevention and treatment may be present but are underused.

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