

Real-world tree nut consumption in peanut-allergic individuals



S. Shahzad Mustafa, MD^{*,†}; Karthik Vadmalai, MD[‡]; Theresa Bingemann, MD^{*,†}; Mahta Mortezaei, MD^{*,†}; Vivian Aranez, MD^{*}; Allison Ramsey, MD^{*,†}

^{*} Rochester Regional Health, Rochester, New York

[†] University of Rochester School of Medicine & Dentistry, Rochester, New York

[‡] Mercy Hospital, Springfield, Missouri

ARTICLE INFO

Article history:

Received for publication September 19, 2019.

Received in revised form October 31, 2019.

Accepted for publication November 25, 2019.

ABSTRACT

Background: Individuals with peanut allergy often avoid tree nuts, yet true rates of tree nut allergy in peanut-allergic individuals are as low as 7%.

Objective: To examine tree nut sensitization patterns in peanut-allergic individuals, patient and family choice regarding tree nut consumption, and factors that influence consumption of tree nuts.

Methods: All patients presenting for peanut allergy evaluation to an outpatient allergy office were included during a 4-month period. In addition to demographic information, sensitization to tree nuts and tree nut consumption were collected. Logistic regression was performed to generate odds ratios with 95% CIs in univariate and multivariate analyses for variables that predict tree nut consumption.

Results: A total of 258 individuals with peanut allergy were enrolled. Ninety-five (36.8%) consumed all tree nuts ad libitum, 63 (24.4%) consumed some but not all tree nuts, and 100 (38.8%) consumed no tree nuts. Of the 100 electively avoiding all tree nuts, the most commonly reported reason was fear of cross-contact (50%). Although there was no difference between rates of sensitization between individual tree nuts ($P = .056$), cashew and pistachio had higher serum specific IgE levels compared with other tree nuts ($P < .001$). The tree nut most commonly consumed by peanut-allergic individuals was almond ($P < .001$). Consumption of foods with precautionary labeling was the strongest predictor of tree nut consumption in peanut allergic individuals ($P < .001$).

Conclusion: Our data highlight the potential for safe introduction of tree nuts in peanut-allergic individuals and indicate that peanut-allergic individuals who consume foods with precautionary labeling are most likely to consume tree nuts.

© 2019 American College of Allergy, Asthma & Immunology. Published by Elsevier Inc. All rights reserved.

Introduction

Peanut allergy affects 1% to 2% of individuals in the United States and is increasing in prevalence.^{1–4} Although there are accumulating data on immunotherapy for peanut allergy,^{5–8} the cornerstone of management remains strict avoidance of peanut protein, maintenance of an emergency action plan, and prompt use of epinephrine to treat systemic reactions in case of an unintentional exposure, which occurs in up to 12% to 15% of peanut-allergic individuals annually.^{9,10} Peanut allergy significantly affects quality of life¹¹ because it is typically lifelong, the leading cause of food-induced

anaphylaxis in children, and the leading cause of food allergy-related deaths.^{12,13} Historically, peanut-allergic individuals were advised to avoid tree nuts for multiple reasons, including concerns about cross-contact,^{14–16} concomitant tree nut allergy,¹⁷ and risk of developing tree nut allergy in the future.¹⁸

Unnecessary avoidance of tree nuts in peanut-allergic individuals may have multiple deleterious effects on overall health and quality of life. Avoidance of multiple foods can adversely affect growth,¹⁹ and tree nuts may be an important source of nutrition in individuals avoiding other foods groups, whether attributable to coexisting food allergies or dietary preference.²⁰ In older children and adolescents with cow's milk and/or soy allergy, despite important differences in nutritional content, tree nut–based milks may be used as a fortified milk source. Tree nut consumption also reduces the risk of cardiovascular disease, total cancer, and all-cause mortality.²¹ Furthermore, patient-reported quality of life decreases as the number of foods being avoided increases.²² The

Reprints: S. Shahzad Mustafa, MD, University of Rochester School of Medicine & Dentistry, Rochester Regional Health, 222 Alexander St, Ste 3000, Rochester, NY 14607; E-mail: shahzad.mustafa@rochesterregional.org.

Disclosures: Dr Mustafa reported serving on the speaker's bureau for Genentech, Teva, AstraZeneca, Regeneron, and CSL Behring. Dr Ramsey reported serving on the speaker's bureau for Regeneron. No other disclosures were reported.

<https://doi.org/10.1016/j.anai.2019.11.027>

1081-1206/© 2019 American College of Allergy, Asthma & Immunology. Published by Elsevier Inc. All rights reserved.

widespread use of precautionary labeling (PAL) makes strict avoidance of tree nuts particularly difficult.²³ Thus, food shopping for a tree nut–allergic individual can be stressful, time consuming, and more costly compared with food shopping for nonallergic individuals.²⁴ In addition, although oral food challenges can improve quality of life in food allergic individuals,²⁵ there are no consensus guidelines on criteria to perform oral food challenge (OFC) to tree nuts, potentially leading to fewer OFCs for tree nuts compared with other foods and continued unnecessary avoidance.

More recently, peanut-allergic individuals have been encouraged to consume tree nuts for which there is no evidence of allergy.²⁶ Previous studies have found that despite high rates of sensitization, the rates of OFC-proven tree nut allergy in peanut-allergic individual is as low as 7%.^{27,28} Nevertheless, there are few data regarding the consumption patterns of tree nuts in peanut-allergic individuals and what factors lead to individual and family decisions to consume or avoid tree nuts in the setting of peanut allergy. We conducted a real-world cross-sectional analysis evaluating tree nut sensitization patterns in peanut-allergic individuals, allergist recommendations regarding tree nut consumption, patient and family choice regarding tree nut consumption, and factors that contribute to these decisions.

Methods

This cross-sectional study was conducted at the Rochester Regional Health outpatient allergy practice in Rochester, New York, from January 2019 through April 2019 with the approval of the institutional review board at Rochester Regional Health. The practice included 4 full-time and 2 part-time allergists who see patients at 3 separate office locations. Five of the 6 physicians participated in this study. All individuals with a diagnosis of peanut allergy based on their allergist's assessment were included in the study.

Peanut allergy was diagnosed based on a history and clinical evaluation suggestive of IgE-mediated hypersensitivity reaction. Symptoms suggestive of an IgE-mediated reaction included cutaneous symptoms (immediate erythematous and/or pruritic dermatitis, urticaria, and/or angioedema), respiratory symptoms (dyspnea, chest tightness, wheezing, or cough), gastrointestinal symptoms (abdominal pain or vomiting) and cardiovascular symptoms (chest discomfort, syncope, or documented hypotension). Anaphylaxis was defined as involvement of 2 or more organ systems with the above-mentioned clinical symptoms. Individuals reporting symptoms suggestive of non-IgE-mediated hypersensitivity or intolerance to peanut were excluded from the study.

Individuals with a clinical history suggestive of IgE-mediated peanut allergy underwent skin prick testing (SPT) and/or measurement of specific IgE (sIgE) as part of their diagnostic evaluation, along with SPT and sIgE for individual tree nuts. Of note, SPT is not available in our practice for pistachio, so pistachio data were limited to sIgE. SPT was completed on the volar forearm or the upper back using the Quintip testing device (Hollister-Stier, Spokane, Washington) with standard peanut or individual tree nut extracts (Stallergenes Greer, Lenoir, North Carolina). A positive test result was defined as a wheal of 3 mm or greater than the saline control in the presence of a positive histamine control. Specific IgE testing was completed with Immulite 2000 (Siemens, Erlangen, Germany). Individuals with an uncertain diagnosis of peanut allergy despite a clinical history, SPT, and sIgE underwent a medically supervised, unblinded OFC that consisted of 6 increasing doses of the peanut protein (peanut butter or peanut candy) given every 15 minutes.

The following data were collected for each peanut-allergic individual: demographic data (age, race, and sex), atopic comorbidities (atopic dermatitis, asthma, allergic rhinitis, and self-reported additional food allergy), peanut reaction history, SPT and sIgE

results at the time of peanut allergy diagnosis, whether the diagnosis was confirmed with an OFC, SPT and sIgE results at the time of study enrollment, history of unintentional ingestions within the past year, and consumption of foods with PAL. Enrolled patients were also assessed for clinical history of a previous reaction to tree nuts and subsequent consumption of almond, cashew, hazelnut, pecan, pistachio, and walnut. Given that brazil nuts were not commonly consumed in our patient cohort, they were not included in the statistical analyses. SPT and sIgE results for individual tree nuts were also recorded, along with the physician recommendation for consumption of individual tree nuts, which included continued consumption at home, introduction at home, introduction through an oral OFC, or continued avoidance. Lastly, we recorded whether individuals who were advised to consume tree nuts did so and, if not, recorded their reason for elective avoidance. Clinical management of tree nut consumption in the setting of peanut allergy was not prespecified for this cross-sectional study and was decided by the individual allergist.

Statistical analysis was performed using Stata software (Stata-Corp LLC, College Station, Texas). Baseline characteristics are described in median, interquartile range (IQR), and frequencies. We used a nonparametric Wilcoxon rank sum test to compare the median wheal and sIgE values for individuals diagnosed with peanut allergy through an OFC vs those diagnosed without an OFC. Kruskal-Wallis test was used to compare the median wheal size and median IgE levels between individual tree nuts. A χ^2 test was used to identify individual tree nut groups with higher proportions of recommended consumption, recommended OFC, and actual consumption and rate of tree nut sensitization in the study population. Logistic regression was used to generate odds ratios (ORs) with 95% CIs in univariate and multivariate analysis for the baseline variables predicting tree nut consumption.

Results

A total of 258 individuals with peanut allergy were enrolled in the study (Table 1). A total of 165 (64.0%) were male, and 92 (36.0%) were female. A total of 136 (52.7%) had atopic dermatitis, 108 (41.9%) had asthma, 163 (63.2%) had allergic rhinitis, and 133 (51.6%) reported additional food allergies. Egg was the most common food allergy reported in peanut-allergic individuals, occurring in 86 individuals (33.3%). In order of decreasing frequency, the other most common reported comorbid food allergies were as follows: 40 (15.5%) with cow's milk allergy, 28 (10.9%) with sesame allergy, 13 (5.0%) with shellfish allergy, 10 (3.9%) with allergy to sunflower seed, 8 (3.1%) with allergy to garbanzo bean, 7 (2.7%) with allergy to finned fish, 7 (2.7%) with allergy to lentil, 6 (2.3%) with soy allergy, and 5 (1.9%) with wheat allergy. Fifty-six patients (21.7%) reported another comorbid food allergy not included in the top 9 most allergenic foods. The most commonly reported history on presentation for peanut allergy was urticaria and/or angioedema, occurring in 111 patients (43.0%); followed by rash, reported by 64 patients (24.8%); anaphylaxis, reported by 43 patients (16.7%); and isolated emesis, reported by 11 patients (4.3%). Twenty-nine patients (11.2%) were diagnosed based on SPT that revealed a wheal of 8 mm or larger and/or sIgE testing revealing a level of 14 kU/L or higher^{29,30} during the evaluation in a child at increased risk for developing peanut allergy, which was typically moderate to severe atopic dermatitis or having a peanut-allergic sibling (per family preference). Of the 258 peanut-allergic individuals, 229 (88.8%) had not experienced an unintentional ingestion of peanut within the past year, whereas 29 (11.2%) had experienced at least 1 unintentional ingestion. Ninety-five (36.8%) consumed foods with PAL, whereas 163 peanut-allergic individuals (63.2%) reported avoiding all foods with PAL.

Table 1
Demographic Characteristics of the Study Participants

Characteristic	Total No. (%) (N = 258)
Male	165 (64.0)
Comorbidities	
Atopic dermatitis	136 (52.7)
Asthma	108 (41.9)
Allergic rhinitis	163 (63.2)
Additional food allergy	133 (51.6)
Additional food allergies	
Egg	86 (33.3)
Cow's milk	40 (15.5)
Sesame	28 (10.9)
Shellfish	13 (5.0)
Sunflower seed	10 (3.9)
Garbanzo bean	8 (3.1)
Finned fish	7 (2.7)
Lentil	7 (2.7)
Soy	6 (2.3)
Wheat	5 (1.9)
Other	56 (21.7)
Presentation at time of peanut allergy diagnosis	
History of urticaria and/or angioedema	111 (43.0)
History of rash	62 (24.8)
History of anaphylaxis	43 (16.7)
History of emesis	11 (4.3)
Diagnosis based on SPT and/or sIgE	29 (11.2)
Diagnosis confirmed with oral food challenge	27 (10.5)
Miscellaneous	
No unintentional ingestion of peanuts within past year	229 (88.8)
Any unintentional ingestion of peanuts within past year	29 (11.2)
Did not consume food with precautionary labeling	163 (63.2)
Consumed foods with precautionary labeling	95 (36.8)

sIgE, specific IgE; SPT, skin prick testing.

At the time of peanut allergy diagnosis, the median age was 1 year (IQR, 0.9–2 years), the median SPT wheal was 10 mm (IQR, 5–10 years), and median sIgE level was 7.89 kU/L (IQR, 2.2–26.6 kU/L) (Table 2). At the time of study enrollment, the median age was 6 years (IQR, 3–10 years), the median SPT wheal was 10 mm (IQR, 5–13 mm), and median sIgE level was 17.4 kU/L (IQR, 3.0–100 kU/L). Twenty-seven patients (10.5%) underwent OFC to confirm the initial diagnosis of peanut allergy attributable to an uncertain clinical history or inconclusive SPT and/or sIgE testing results. Significant differences were found among individuals diagnosed with peanut allergy without an OFC and those who underwent a medically supervised oral food challenge to confirm the diagnosis of peanut allergy. Individuals who underwent an OFC had a significantly less reactive skin prick test wheal (5 mm [IQR, 3–8 mm] vs 10 mm [IQR, 5–15 mm], $P = .007$) and significantly lower sIgE levels (1.8 kU/L [IQR, 0.5–4.6 kU/L] vs 27.4 kU/L [IQR, 4.1–100 kU/L], $P < .001$) (Table 3). Of the 258 peanut-allergic individuals, 95 (36.8%) consumed all tree nuts ad libitum in their diet, 63 (24.4%) consumed some but not all tree nuts, and 100 (38.8%) consumed no tree nuts. Of the 100 individuals avoiding all tree nuts, 50 (50.0%) reported this was because of perceived risk of cross-contact, 16 (16.0%) reported no desire to consume any tree nuts, 13 (13.0%) were avoiding because of young age, 12 (12.0%) were avoiding

Table 2
Comparison of Peanut Wheal and Peanut sIgE at Time of Peanut-Allergy Diagnosis vs Time of Study Enrollment

Variable	At diagnosis, median (IQR)	At enrollment, median (IQR)
Age, y	1 (0.9–2)	6 (3–10)
Wheal, mm	10 (5–10)	10 (5–13)
sIgE, kU/L	7.89 (2.2–26.6)	17.4 (3.0–100)

IQR, interquartile range; sIgE, specific IgE.

Table 3
Comparison of Peanut Wheal and Peanut sIgE Between Peanut-Allergic Individuals Diagnosed With an OFC vs those diagnosed without an OFC

Variable	Diagnosed with OFC	Diagnosed without OFC	P value
Patients, No. (%)	27 (10.4)	231 (89.5)	NA
Wheal, median (IQR), mm	5 (3–8)	10 (5–15)	.007
sIgE, median (IQR), kU/L	1.8 (0.5–4.6)	27.4 (4.1–100)	<.001

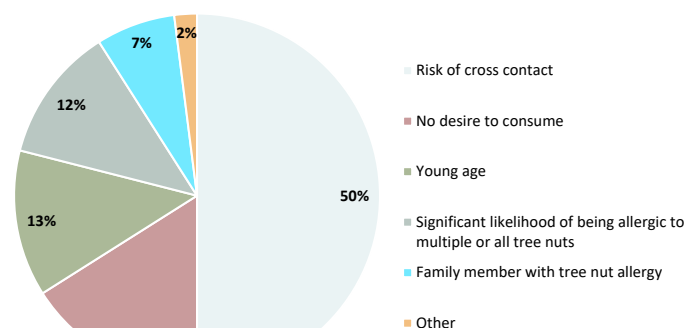
IQR, interquartile range; OFC, oral food challenge; sIgE, specific IgE.

because of a high likelihood of being allergic (based on previous clinical reactivity, tree nut SPT result ≥ 8 mm, and/or sIgE level ≥ 15 kU/L), 7 (7.0%) were avoiding because of a family member being allergic, and 2 (2.0%) were avoiding all tree nuts for other reasons (Fig. 1).

No difference was found between rates of sensitization (SPT and sIgE) between individual tree nuts (almond, 45.3%; cashew, 54.3%; hazelnut, 50.8%; pecan, 43.4%; pistachio, 43.0%; and walnut, 45.7%; $P = .056$). There was also no difference between the median size of the wheal for individual tree nuts (Fig. 2A). Cashew (5.31 kU/L; IQR, 0.79–24.1 kU/L) and pistachio (7.12 kU/L; IQR, 0.78–28.65 kU/L) had significantly higher sIgE levels compared with other tree nuts (0.69 kU/L [0.27–2.19 kU/L] for almond, 1.38 kU/L [IQR, 0.45–4.28 kU/L] for hazelnut, 1.20 kU/L [IQR, 0.23–13.2 kU/L] for pecan, 2.16 kU/L [IQR, 0.57–17.60 kU/L] for walnut; $P < .001$) (Fig. 2B).

In peanut-allergic individuals, almond was recommended to be consumed significantly more often compared with other tree nuts (almond, 73.3%; cashew, 51.6%; hazelnut, 65.9%; pecan, 69.8%; pistachio, 51.6%; walnut, 68.8%; $P < .001$) (Fig. 3). Of note, recommendations for consumption of cashew and pistachio (both 51.6%) and pecan and walnut (69.8% and 68.8%, respectively) tracked together. OFC to almond (15.9%) and hazelnut (15.9%) was recommended significantly more often compared with other tree nuts (cashew, 8.9%, pecan, 7.4%, pistachio, 5.8%, walnut, 9.7%; $P < .001$). Lastly, peanut-allergic individuals consumed almond (57.0%) significantly more often than they consumed other tree nuts (cashew, 32.6%; hazelnut, 43.0%; pecan, 39.5%; pistachio, 29.8%; walnut, 38.8%; $P < .001$).

Univariate analysis showed the following variables were predictors of tree nut consumption in peanut-allergic individuals: consumption of foods despite precautionary labeling (OR, 5.91; 95% CI, 3.09–10.93; $P < .001$) and having peanut allergy in the absence of other food allergy (OR, 2.14; 95% CI, 1.28–3.57; $P = .004$) (Table 2). Having sesame allergy (OR, 0.36; 95% CI, 0.16–0.81; $P = .01$) or allergy to other foods outside the top 9 food allergens (OR, 0.44; 95% CI, 0.23–0.80; $P = .008$) made it less likely for peanut-allergic

**Figure 1.** Reported reasons for avoidance of all tree nuts.

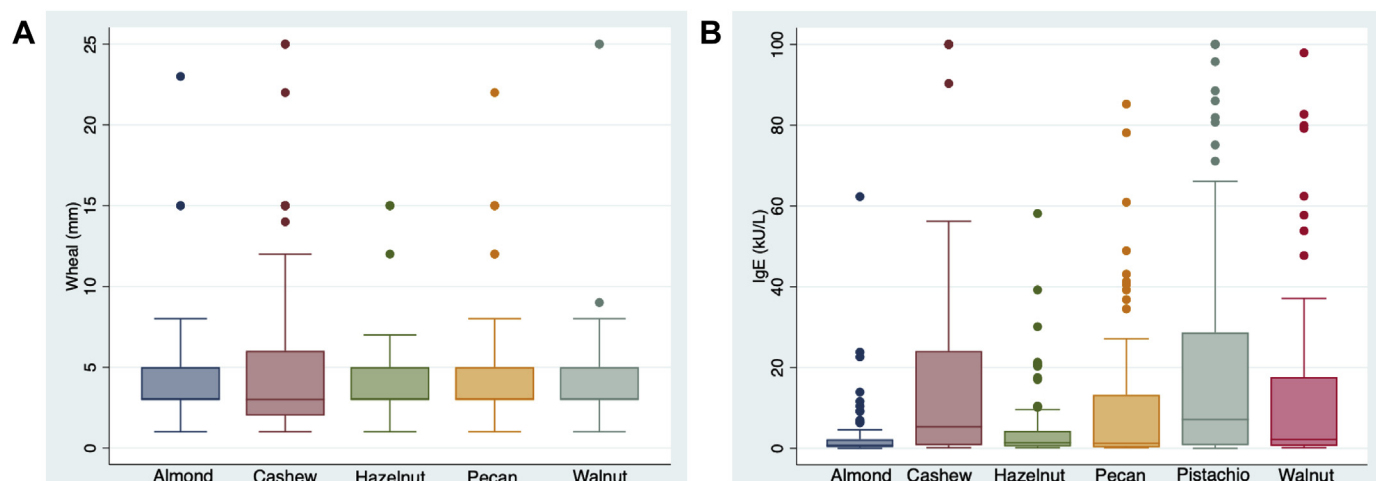


Figure 2. Box plots of median wheal size (A) and median specific IgE (sIgE) levels (B) with interquartile range for individual tree nuts.

individual to consume tree nuts. Multivariate analysis revealed that consumption of foods with PAL was a significant predictor of tree nut consumption in peanut-allergic individuals (OR, 5.69; 95% CI, 2.98–10.87; $P < .001$) (Table 4).

Discussion

This study evaluates the real-world consumption of tree nuts in peanut-allergic individuals. In addition to evaluating the rates of sensitization to tree nuts, which has been previously reported, we also quantified the degree of sensitization and the individual and family factors that led to a decision of whether to consume tree nuts in the setting of peanut allergy. The atopic characteristics of our peanut-allergic cohort, including the presence of atopic dermatitis (52.7%), allergic rhinitis (63.2%), asthma (41.9%), and additional food allergy (51.5%), are in line with previous studies of peanut-allergic individuals.^{28,30–33} In addition, the median age at diagnosis (1 year) and the incidence of unintentional exposure to peanut is also consistent with previous reports. Importantly,

although only 10.4% of our cohort had their initial diagnosis of peanut allergy confirmed with an OFC, the individuals who were diagnosed based on history and testing alone all had clinically suggestive histories, with a median SPT wheal of 10 mm and a median peanut sIgE level 27.4 kU/L, making it likely that all 258 individuals were truly peanut allergic.

Our study reveals that the rates of sensitization for various tree nuts ranged from 43.0% to 54.3%. Although these rates are lower than reported rates of 49% to 78% by Maloney et al,¹⁷ they are consistent with or slightly higher than recent reported rates of 38% to 50% by Anagnostou.³⁴ We found that the sIgE levels for cashew and pistachio were significantly higher compared with other tree nuts, with almond and hazelnut showing the lowest values, which is similar to the findings of the study by Anagnostou,³⁴ which showed that cashew had the highest degree of sensitization, whereas almond had the lowest degree of sensitization. The frequent rates of sensitization reported in our study and by Anagnostou³⁴ likely account for the high rates of self-reported coallergy between peanut and tree nuts, up to 20%

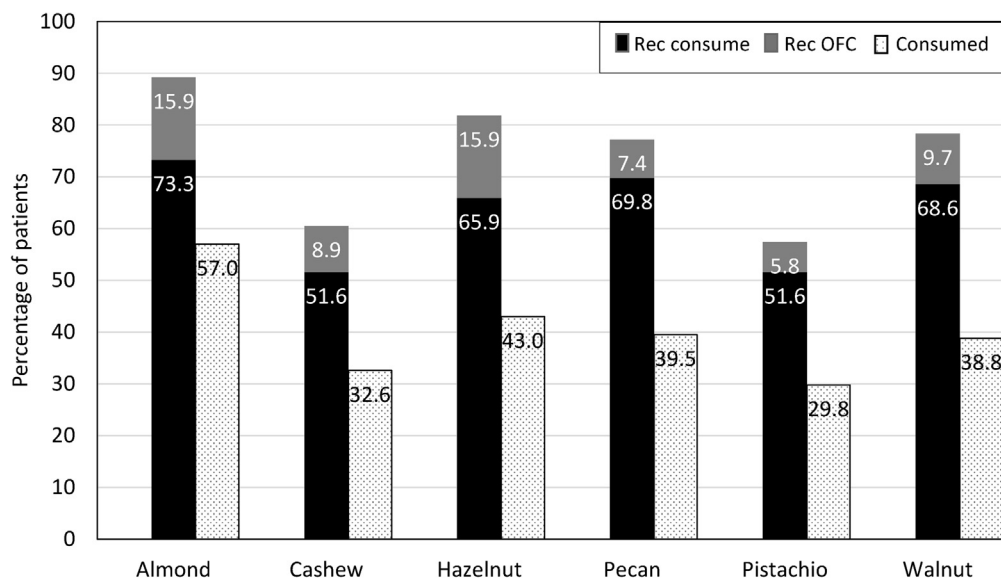


Figure 3. Percentage of individuals who were recommended consumption of tree nuts (rec consume), recommended oral food challenge (rec OFC), and who consumed tree nuts (consumed).

Table 4

Univariate and Multivariate Analysis: Association Between Tree Nut Consumption and Baseline Characteristics

Characteristic	Odds ratio (95% CI)	P value
Univariate analysis		
Consumption of foods with PAL	5.811 (3.09–10.92)	<.001
Peanut allergy without other food allergy	2.14 (1.28–3.57)	.004
Concurrent food allergy outside top 9	0.438 (0.23–0.80)	.008
Concurrent sesame allergy	0.36 (0.16–0.81)	.01
Increasing peanut sIgE	0.69 (0.36–1.29)	.23
Concurrent egg allergy	0.76 (0.45–1.29)	.32
Concurrent cow's milk allergy	0.73 (0.37–1.45)	.38
Increasing age of patient	0.98 (0.94–1.02)	.47
Unintentional ingestion of peanut	0.75 (0.34–1.64)	.48
Multivariate analysis		
Consumption of foods with PAL	5.69 (2.98–10.87)	<.001
Concurrent sesame allergy	0.42 (0.16–1.10)	.08
Concurrent food allergy outside top 9	0.58 (0.27–1.25)	.17
Peanut allergy without other food allergy	1.27 (0.65–2.4)	.48

PAL, precautionary labeling; sIgE, specific IgE.

to 59%,^{17,35} and likely contribute to the previous inclination toward recommending tree nut avoidance in peanut-allergic individuals.

Emerging data have shown that peanut-allergic individuals with tree nut sensitization will frequently pass OFCs,²⁸ and the rate of true tree nut allergy in peanut-allergic individuals is much lower than the commonly reported figure of 30%.^{27,36} Our results indicate that up to 73.3% of peanut-allergic individuals were advised to consume almonds at home, with an additional 15.9% being offered OFCs. Thus, up to 89.2% of peanut-allergic individuals in our cohort could potentially consume almonds. Two-thirds of patients were also counseled that introduction of hazelnut would be safe, with 15.9% also being offered OFCs to facilitate introduction of hazelnut into the diet. Pecan and walnut were also frequently offered in the diet of peanut-allergic individuals (77.2% and 78.3%, respectively). Despite cashews and pistachios having the highest rate of potential coallergy in our cohort, nearly 60% of peanut-allergic individuals were still offered home or office introduction of these tree nuts.

Our results clearly indicate that individual tree nuts have unique characteristics in the context of peanut allergy. Dietary recommendations should therefore reflect these individual differences. The particularly high rates of sensitization to almond and hazelnut in the absence of clinical allergy may be attributable to cross-reactivity with birch pollen.³⁷ Pecans and walnuts have significant homology, as do cashews and pistachios, and management frequently is consumption of, or avoidance of, both pairs of tree nuts.³⁸ Our findings are consistent with this because the recommendations for consumption of cashew and pistachio as well as pecan and walnut were similar. Cashews and pistachios also appear to have the highest degree of sensitization and may present with the most severe clinical reactions,³⁹ which may have led to the lower rates of recommended consumption by allergists and the lower rate of consumption by patients. These similarities and differences, along with local dietary patterns, likely influence tree nut consumption in peanut-allergic individuals.

In our study, almonds were the most commonly consumed tree nut and the most commonly accepted OFC, likely because almonds are the most common tree nut in the American diet.³⁷ Practical factors, such as almond being available as almond butter and almond milk, may also influence dietary introduction, particularly in a pediatric population. In addition, when evaluating OFCs to tree nuts, Couch et al²⁸ reported that OFCs to almond were passed by all 54 patients in their cohort, 36 of whom had concurrent peanut allergy.²⁸ Brazil nut was so rarely desired to be incorporated into the diet that we excluded it from our analysis. This finding

highlights the importance of counseling peanut-allergic individuals and families on individual tree nuts rather than classifying them as an all or nothing class of food.

Although most peanut-allergic individuals and families were advised to introduce tree nuts at home or through OFCs, nearly 40% elected to voluntarily avoid all tree nuts. The most commonly cited reason was to minimize the risk of cross-contact. Our study emphasizes potentially important characteristics of families choosing this strategy out of an abundance of caution. Individuals with additional food allergy along with peanut allergy, especially sesame allergy, were more likely to electively avoid all tree nuts, potentially because of a perceived higher risk of cross-contact. This finding further highlights the importance of the proper evaluation and diagnosis of comorbid food allergies in individuals with peanut allergy as we aim to provide peanut-allergic individuals with the most liberal diet possible.

In our study, the most important predictor of tree nut consumption was an individual or family's willingness to consume foods with PAL. If individuals or families with peanut allergy were comfortable consuming foods with PAL, they were significantly more likely to broaden their diet to include tree nuts. This finding stresses the importance of discussing the utility of PAL in the management of food allergy. Although the food allergy practice parameters advise avoiding foods with PAL,²⁹ several studies on the clinical utility of PALs have yielded varied results, and consumption of foods with PAL has increasingly become an individual decision based on shared decision making.^{40,41} Our data add to the literature highlighting the potential restrictive effect of avoiding foods with PAL, including the avoidance of tree nuts in the setting of peanut allergy, and the importance of discussing the clinical relevance of PAL with peanut-allergic individuals.⁴²

Reasons for elective avoidance of tree nuts in the setting of peanut allergy may change over time, as the individual grows older, or as food allergic siblings mature or outgrow their food allergies. The discussion regarding tree nut consumption in the setting of peanut allergy should therefore be periodically revisited. The health benefits of tree nuts is also a reason to revisit their inclusion into the diet, particularly in patients with multiple food allergies,¹⁹ or as peanut-allergic individuals age into adulthood. We also hypothesize that with soon to be US Food and Drug Administration–approved therapies for peanut allergy, individuals and families avoiding only peanuts may find these therapies to be more clinically meaningful compared with individuals and families avoiding multiple foods, such as peanuts and tree nuts.⁴³ As additional therapies become available for peanut-allergic individuals, discussing tree nut consumption may take on even greater clinical relevance.

We acknowledge important limitations to our study. Not all of peanut-allergic cohort had their diagnosis confirmed with an OFC. Similarly, a small percentage of patients were told to avoid certain tree nuts based on SPT test and sIgE test alone, in the absence of a clinical history of reaction. However, these individuals had SPT results or sIgE levels at or above the 95% positive predictive value for reacting to an OFC.^{29,30} Peanut-allergic patients not consuming tree nuts routinely underwent SPT and sIgE testing for tree nuts, which may not be necessary and could be considered overtesting. The intent of this testing in our practice was to reassure individuals and families in hopes of facilitating the introduction of tree nuts into the diet. Lastly, despite increasing clinical availability, we did not use component-resolved diagnostic testing for the diagnosis of peanut or tree nut allergy. Despite these limitations, we believe that our results add valuable insight to the real-world consumption of tree nuts in peanut-allergic individuals.

In summary, our data support previous work showing that peanut-allergic individuals are commonly sensitized to tree nuts.

We have highlighted important differences between individual tree nuts, challenging the common practice of categorical management recommendations for tree nuts as a whole group rather than by individual tree nut. We have also shown that peanut-allergic individuals with no other food allergies who consume foods with PAL are the most likely to consume some or all tree nuts. This information can better inform counseling of peanut-allergic individuals to allow for potential consumption of tree nuts.

References

- Sicherer SH, Muñoz-Furlong A, Sampson HA. Prevalence of peanut and tree nut allergy in the United States determined by means of a random digit dial telephone survey: a 5-year follow-up study. *J Allergy Clin Immunol*. 2003;112:1203–1207.
- Grundy J, Matthews S, Bateman B, Dean T, Arshad SH. Rising prevalence of allergy to peanut in children: data from 2 sequential cohorts. *J Allergy Clin Immunol*. 2002;110:784–789.
- Sicherer SH, Muñoz-Furlong A, Godbold JH, Sampson HA. US prevalence of self-reported peanut, tree nut, and sesame allergy: 11-year follow-up. *J Allergy Clin Immunol*. 2010;125:1322–1326.
- Sampson HA, Aceves S, Bock SA, James J, Jones S, Lang D, et al. Food allergy: a practice parameter update-2014. *J Allergy Clin Immunol*. 2014;134:1016–1025.
- Vickery BP, Vereda A, Casale TB, et al. AR101 Oral immunotherapy for peanut allergy. *N Engl J Med*. 2018;379:1991–2001.
- Vickery BP, Berglund JP, Burk CM, et al. Early oral immunotherapy in peanut-allergic preschool children is safe and highly effective. *J Allergy Clin Immunol*. 2017;139:173–181.
- Jones SM, Sicherer SH, Burks AW, et al. Epicutaneous immunotherapy for the treatment of peanut allergy in children and young adults. *J Allergy Clin Immunol*. 2017;139:1242–1252.
- Fleischer DM, Greenhawt M, Sussman G, et al. Effect of epicutaneous immunotherapy vs placebo on reaction to peanut protein ingestion among children with peanut allergy: the PEPITES randomized clinical trial. *JAMA*. 2019;321:946–955.
- Yu JW, Kagan R, Verreault N, et al. Accidental ingestions in children with peanut allergy. *J Allergy Clin Immunol*. 2006;118:466–472.
- Cherkaoui S, Ben-Shoshan M, Alizadehfard R, et al. Accidental exposures to peanut in a large cohort of Canadian children with peanut allergy. *Clin Translational Allergy*. 2015;5:16–22.
- Cummings AJ, Knibb RC, King RM, Lucas JS. The psychosocial impact of food allergy and food hypersensitivity in children, adolescents, and their families: a review. *Allergy*. 2010;65:933–945.
- Bock SA, Muñoz-Furlong A, Sampson HA. Fatalities due to anaphylactic reactions to foods. *J Allergy Clin Immunol*. 2001;107:191–193.
- Hourihane JO, Kilburn SA, Dean P, Warner JO. Clinical characteristics of peanut allergy. *Clin Exp Allergy*. 1997;27:634–639.
- Du Toit G, Lack G. Optimizing the diagnosis of peanut and tree nut allergy. *Clin Exp Allergy*. 2003;33:1019–1022.
- Muraro A, Roberts G, Clark A, et al. The management of anaphylaxis in childhood: position paper of the European Academy of Allergy and Clinical Immunology. *Allergy*. 2007;62:857–871.
- Ewan PW. Clinical study of peanut and nut allergy in 62 consecutive patients: new features and associations. *BMJ*. 1996;312:1074–1078.
- Maloney JM, Rudengren M, Ahlstedt S, Bock SA, Sampson HA. The use of serum specific IgE measurements for the diagnosis of peanut, tree nut, and sesame allergy. *J Allergy Clin Immunol*. 2008;122:145–151.
- Clark AT, Ewan PW. The development and progression of allergy to multiple nuts at different ages. *Pediatr Allergy Immunol*. 2005;16:507–511.
- Flammarion S, Santos C, Guimber D, et al. Diet and nutritional status of children with food allergies. *Pediatr Allergy Immunol*. 2011;22:161–165.
- Marsh K, Zeuschner C, Saunders A, Reid M. Meeting nutritional needs on a vegetarian diet. *Aust Fam Physician*. 2009;38:600–602.
- Aune D, Keum N, Giovannucci E, et al. Nut consumption and risk of cardiovascular disease, total cancer, all-cause and cause-specific mortality: a systematic review and dose-response meta-analysis of prospective studies. *BMC Med*. 2016;14:207–220.
- Howe L, Franxman T, Teich E, Greenhawt M. What affects quality of life amongst caregivers of food-allergic children? *Ann Allergy Asthma Immunol*. 2013;113:69–74.
- Brough HA, Turner PJ, Wright T, et al. Dietary management of peanut and tree nut allergy: what exactly should patients avoid? *Clin Exp Allergy*. 2015;45:859–871.
- Primeau MN, Kagan R, Joseph L, et al. The psychological burden of peanut allergy as perceived by adults with peanut allergy and the parents of peanut-allergic children. *Clin Exp Allergy*. 2000;30:1135–1143.
- Van der Velde JL, Flokstra-de Blok BM, de Groot H, et al. Food allergy-related quality of life after double-blind, placebo-controlled food challenges in adults, adolescents, and children. *J Allergy Clin Immunol*. 2012;130:1136–1143.
- Gulland A. Nut allergy guidelines discourage complete avoidance. *BMJ*. 2017;357:3705.
- Ball H, Luyt D, Bravin K, Kirk K. Single nut or total nut avoidance in nut allergic children: outcome of nut challenges to guide exclusion diets. *Pediatr Allergy Immunol*. 2011;22:808–812.
- Couch C, Franxman T, Greenhawt M. Characteristics of tree nut challenges in tree nut allergic and tree nut sensitized individuals. *Ann Allergy Asthma Immunol*. 2017;118:591–596.
- Boyce JA, Assa'ad A, Burks AW, et al. Guidelines for the diagnosis and management of food allergy in the United States: report of the NIAID-sponsored expert panel. *J Allergy Clin Immunol*. 2010;126:S1–S58.
- Sicherer SH, Sampson HA. Food allergy: epidemiology, pathogenesis, diagnosis, and treatment. *J Allergy Clin Immunol*. 2014;133:291–307.
- Green TD, LaBelle VS, Steele PH, et al. Clinical characteristics of peanut-allergic children: recent changes. *Pediatrics*. 2007;120:1304–1310.
- Peters RL, Allen KJ, Dharmage SC, et al. Natural history of peanut allergy and predictors of resolution in the first 4 years of life: a population-based assessment. *J Allergy Clin Immunol*. 2015;135:1257–1266.
- Du Toit G, Roberts G, Sayre PH, et al. Randomized trial of peanut consumption in infants at risk for peanut allergy. *N Engl J Med*. 2015;372:803–813.
- Anagnostou A. Insights into tree nut and sesame consumption from a cohort of 80 peanut-allergic children. *Pediatr Allergy Immunol*. 2019;30:389–392.
- Sicherer SH, Furlong TJ, Muñoz-Furlong A, Burks AW, Sampson HA. A voluntary registry for peanut and tree nut allergy: characteristics of the first 5149 registrants. *J Allergy Clin Immunol*. 2001;108:128–132.
- Elizur A, Appel MY, Nachshon L, et al. NUT Co Reactivity - Acquiring Knowledge for Elimination Recommendations (NUT CRACKER) study. *Allergy*. 2018;73:593–601.
- Uotila R, Kukkonen AK, Blom WM, et al. Component-resolved diagnostics demonstrates that most peanut-allergic individuals could potentially introduce tree nuts to their diet. *Clin Exp Allergy*. 2018;48:712–721.
- Smekens JM, Bagley K, Kulis M. Tree nut allergies: allergen homology, cross-reactivity, and implications for therapy. *Clin Exp Allergy*. 2018;48:762–772.
- Clark AT, Anagnostou K, Ewan PW. Cashew nut causes more severe reactions than peanut: case-matched comparison in 141 children. *Allergy*. 2007;62:913–916.
- Allen KJ, Taylor SL. The consequences of precautionary allergen labeling: safe haven or unjustifiable burden? *J Allergy Clin Immunol Pract*. 2018;6:400–407.
- Turner PJ, Allen KJ, Mehr S, Campbell DE. Knowledge, practice, and views on precautionary allergen labeling for the management of patients with IgE-mediated food allergy: a survey of Australasian and UK health care professionals. *J Allergy Clin Immunol Pract*. 2016;4:165–167.
- Papadopoulos A, Elegbede CF, Ait-Dahmane S, Dubuisson C, Deschildre A, Crépét A. Tree nut allergy and anxiety related factors modulate food consumption behaviour in peanut-allergic patients: results of the MIRABEL survey. *Regul Toxicol Pharmacol*. 2018;99:191–199.
- Bird JA. Food oral immunotherapy is superior to food avoidance-PRO. *Ann Allergy Asthma Immunol*. 2019;122:566–568.