TABLE I. Peanut skin prick test results

	<8 mm	≥8 mm	*P* value
S aureus colonization	227 (41%)	322 (59%)	.01
No *S aureus* colonization	89 (53%)	79 (47%)	

Peanut allergy determined by using skin prick tests was defined as a wheal size of 8 mm or greater, which is associated with a 95% to 100% positive predictive value for peanut allergy.[8] *P* values were determined by using the Fisher exact test.

those without *S aureus* colonization (70% vs 48%, $P < .0001$). Diagnostic code for anaphylaxis, prescription for an epinephrine autoinjector, or both were also found to be significantly more prevalent in patients with *S aureus* colonization versus those without *S aureus* colonization (53% vs 44%, $P = .04$; see Tables E1 and E2 in this article's Online Repository at www.jacionline.org).

These data suggest there is an association between *S aureus* colonization and food allergy to peanut, egg white, and cow's milk in patients with AD. *S aureus* is a pathogenic microbe that produces multiple virulence factors (eg, superantigens, cytolysins, proteases, lipases, protein A, and microbial surface components recognizing adhesive matrix molecules) that can lead to break down of the epithelial barrier.[9] Additionally, exposure of murine models to *S aureus* toxin leads to increased T_H2-mediated responses[4,5] and decreased regulatory T-cell function,[4] both of which are described in patients with food allergy.[10] We propose that the skin microbiome plays an important role in skin barrier function and directs immune responses. Aberrancies in the skin microbiome, including *S aureus* colonization, lead to skin barrier dysfunction and immune dysregulation, ultimately contributing to the development of food allergy through topical exposure of antigen.

Furthermore, these findings show a unique association between peanut allergy and MRSA because peanut sIgE levels were higher in patients with MRSA colonization compared with those with MSSA. These findings support the theory that *S aureus* causes skin breakdown, leading to epicutaneous absorption of peanut. MRSA produces more superantigens than MSSA[9] and might be contributing to more significant skin barrier breakdown. Additionally, studies have demonstrated that peanut allergy, in particular, occurs through epicutaneous allergen absorption.[2,3]

These results are of particular relevance to the events that predispose subjects to food allergy. Recent studies have demonstrated that environmental peanut drives sensitization and peanut allergy in patients with AD.[2] Further studies looking at peanut protein and *S aureus* in house dust could shed new light on the effect of *S aureus* and food allergy. The clinical relevance to our findings are suggested by increased diagnostic codes for anaphylaxis, epinephrine autoinjector prescription, or both in patients with *S aureus* colonization, indicating there was physician concern for clinically relevant food allergy.

In the future, studies are needed to assess the association between *S aureus* skin colonization and food allergy in patients with AD. Confirmation of our current observations open up the possibility that therapy directed at eradicating *S aureus* colonization will be important in the prevention of food allergen sensitization and possibly food allergy in patients with AD.

Andrea L. Jones, MD[a]
Douglas Curran-Everett, PhD[a,c]
Donald Y. M. Leung, MD, PhD, FAAAAI[a,b,c]

From [a]the Department of Pediatrics and [c]the Division of Biostatistics and Bioinformatics, National Jewish Health, Denver, Colo, and [b]the Department of Pediatrics, University of Colorado at Denver and Health Sciences Center, Aurora, Colo. E-mail: leungd@njhealth.org.

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REFERENCES

1. Leung DY, Guttman-Yassky E. Deciphering the complexities of atopic dermatitis: shifting paradigms in treatment approaches. J. Allergy Clin Immunol 2014;134:769-79.
2. Brough HA, Simpson A, Makinson K, Hankinson J, Brown S, Douiri A, et al. Peanut allergy: effect of environmental peanut exposure in children with filaggrin loss-of-function mutations. J Allergy Clin Immunol 2014;134:867-75.
3. Brough HA, Liu AH, Sicherer S, Makinson K, Douiri A, Brown SJ, et al. Atopic dermatitis increases the effect of exposure to peanut antigen in dust on peanut sensitization and likely peanut allergy. J Allergy Clin Immunol 2015;135:164-70.
4. Ganeshan K, Neilsen CV, Hadsaitong A, Schleimer RP, Luo X, Bryce PJ. Impairing oral tolerance promotes allergy and anaphylaxis: a new murine food allergy model. J Allergy Clin Immunol 2009;123:231-8.
5. Forbes-Blom E, Camberis M, Prout M, Tang SC, Le Gros G. Staphylococcal-derived superantigen enhances peanut induced Th2 responses in the skin. Clin Exp Allergy 2012;42:305-14.
6. Sicherer SH, Sampson HA. Food allergy: epidemiology, pathogenesis, diagnosis, and treatment. J Allergy Clin Immunol 2014;133:291-307.
7. Merkel PA, O'Sullivan MD, Ridge C, Knight V. Critique on the quantitative nature of IgE antibody measurements. J Allergy Clin Immunol Pract 2015;3:973-5.
8. Roberts G, Lack G. Diagnosing peanut allergy with skin prick and specific IgE testing. J Allergy Clin Immunol 2005;115:1291.
9. Schlievert PM, Strandberg KL, Lin Y-C, Peterson ML, Leung DYM. Secreted virulence factor comparison between methicillin-resistant and methicillin-sensitive *Staphylococcus aureus*, and its relevance to atopic dermatitis. J Allergy Clin Immunol 2010;125:39-49.
10. Jones SM, Burks AW, Dupont C. State of the art on food allergen immunotherapy: oral, sublingual, and epicutaneous. J Allergy Clin Immunol 2014;133:318-23.

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Household almond and peanut consumption is related to the development of sensitization in young children

To the Editor:

Nut allergy is one of the most common and severe food allergies in children. Therefore understanding the causes of nut allergy is essential to establishing primary preventive measures to avoid the onset of this condition.

The most significant risk factor for children in terms of having food allergy is atopic dermatitis (AD). Food allergy has also been associated with genetic, molecular, dietary, and environmental factors.[1] The early introduction of allergenic foods in children's diets appears to prevent the development of allergy.[2-4] Moreover, in recent years, several studies have shown that there is a clear relationship between household peanut consumption and allergy, especially in children with eczema or other skin barrier function disorders, which supports the concept of a transcutaneous sensitization pathway.[5-7]

The aim of this study was to assess the association between consumption of various types of nuts (almonds, walnuts, and peanuts) in domestic settings by family members who live with the children and sensitization to these foods in children younger than 18 months who had not yet had the foods introduced to their diets.

TABLE I. Univariate analysis of the association between predictors and sensitization to almond, walnut, and peanut

Predictor	Total (n = 96)	Positive almond SPT response				Positive walnut SPT response				Positive peanut SPT response			
		No.	Percent	*P* value*	OR (95% CI)	No.	Percent	*P* value*	OR (95% CI)	No.	Percent	*P* value*	OR (95% CI)
Sex													
Male	61	11	18.0	.912	1.06 (0.36-3.18)	4	6.6	.650	2.39 (0.26-22.24)	6	9.8	.217†	0.44 (0.13-1.42)
Female	35	6	17.1			1	2.9			7	20.0		
Age													
> Median	48	9	18.8	.789	1.15 (0.40-3.30)	1	2.1	.362	0.23 (0.03-2.18)	4	8.3	.136	0.39 (0.11-1.38)
< Median	48	8	16.7			4	8.3			9	18.7		
Breast-feeding													
Yes	87	17	19.5	.354†	Incalculable	5	5.7	1.000	Incalculable	13	14.9	.605†	Incalculable
No	9	0	0.0			0	0.0			0	0.0		
Family history													
Yes	60	12	20.0	.282	1.94 (0.57-6.55)	5	8.3	.154	Incalculable	8	13.3	1.000†	1.19 (0.33-4.29)
No	35	4	11.4			0	0.0			4	11.4		
≥2 members	28	7	25	.229†	2.15 (0.71-6.50)	2	7.1	.630†	1.64 (0.26-10.40)	5	17.9	.328†	1.86 (0.54-6.47)
<2 members	67	9	13.4			3	4.5			7	10.4		
AD													
Yes	65	15	23.1	**.046**†	4.35 (0.93-20.39)	5	7.7	.171	Incalculable	12	18.5	**.055**†	6.79 (0.84-54.84)
No	31	2	6.5			0	0.0			1	3.2		
Severity score													
> Median	47	14	29.8	**.002**	6.51 (1.73-24.47)	3	6.4	.674	1.60 (0.26-10.05)	10	21.3	**.030**	4.14 (1.06-16.16)
< Median	49	3	6.1			2	4.1			3	6.1		
Egg sensitization													
Yes	55	16	29.1	**.001**	16.41 (2.08-129.77)	2	3.6	.648†	0.48 (0.08-3.00)	11	20.0	**.032**	4.88 (1.02-23.36)
No	41	1	2.4			3	7.3			2	4.9		
Household almond consumption													
Yes	65	17	26.2	**.002**	Incalculable								
No	31	0	0.0										
Household walnut consumption													
Yes	72					5	6.9	.327	Incalculable				
No	24					0	0.0						
Household peanut consumption													
Yes	60									13	21.7	**.002**†	Incalculable
No	36									0	0.0		

Values in boldface indicate statistical significance.
*χ^2 Test.
†Fisher exact test.

A prospective study was conducted on children between the ages of 3 and 18 months who had not eaten peanuts or tree nuts and were not known to be sensitized or allergic. The consumption of nuts at home by relatives who lived with the children was recorded by using a questionnaire administered by the allergist before performing allergy testing. SPTs with almond, walnut, and peanut extracts were performed on all the children. A child was considered sensitized if he or she had a positive SPT response (see the Methods section in this article's Online Repository at www.jacionline.org).

A total of 96 children were included in the study. The primary clinical characteristics are listed in Table E1 in this article's Online Repository at www.jacionline.org. Data on the consumption of nuts are listed in Table E2 in this article's Online Repository at www.jacionline.org.

Twenty-four (25%) of the children were sensitized to 1 or more of the analyzed foods. A total of 35 sensitizations in the 96 children were detected: 17 to almond, 13 to peanut, and 5 to walnut.

Table E3 in this article's Online Repository at www.jacionline.org shows the distribution of children sensitized to almond, walnut, and peanut based on households consuming almond, walnut, and peanut, respectively. The sensitization rate was greater for almond (26.2%) and peanut (21.7%) than for walnut (6.9%; almond vs walnut, $P = .002$; peanut vs walnut, $P = .014$).

Data from the univariate analysis are shown in Table I. Home consumption of almonds, AD (presence and severity), and egg sensitization had a statistically significant association with sensitization to this nut. The results of the peanut sensitization analysis are similar to those of the almond analysis.

Regarding walnut consumption, a similar numeric trend was observed; however, a statistically significant association was not found, probably because of the low number of children sensitized.

The results of the analysis stratified by AD (presence and severity) and egg sensitization are presented in Table E4 in this article's Online Repository at www.jacionline.org. As shown, these covariates behaved as modifying factors on the effect of almond consumption in sensitization to this nut, so that the association between consumption and sensitization is only held in one of the stratum (children with AD, children with higher severity scores, and children sensitized to egg) but not the others. These results were similar in the case of peanut.

Assessment of the magnitude of the association between consumption and sensitization to nuts and the modifying effect of covariates on this association was not possible because of the absence of sensitized children among the unexposed subjects.