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**ALLERGIC CONTACT DERMATITIS TO PERSONAL CARE PRODUCTS AND
TOPICAL MEDICATIONS IN ADULTS WITH ATOPIC DERMATITIS**

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37 **Capsule summary**

- 38 • The association between atopic dermatitis (AD) and allergic contact dermatitis (ACD) is not well
39 understood.
- 40 • We found that AD was associated with contact hypersensitivity to ingredients found in emollients
41 and topical medications, and with sensitivity to multiple allergens.
- 42 • Patch testing should be considered for patients with AD who do not improve with standard
43 measures.

ABSTRACT

Background: Atopic dermatitis (AD) is associated with skin-barrier disruption, immune dysregulation, and application of emollients and topical medications, which may predispose towards developing allergic contact dermatitis (ACD).

Objective(s): To determine the predictors of ACD and relevant allergens in AD.

Methods: A retrospective chart review was performed of 502 adults (age ≥ 18 years) who were patch-tested to an expanded allergen series from 2014-2017.

Results: Overall, 108 (21.5%) had current AD and 109 (21.7%) had past AD. Patients with vs. without current AD had similar proportions of any positive (+/++/+++): 80 [74.1%] vs. 254 [64.5%]; Chi-square, $P=0.06$), stronger (++/+++): 34 [31.5%] vs. 102 [25.9%], $P=0.25$) and irritant (56 [51.9%] vs. 188 [47.7%], $P=0.45$) patch test reactions. AD patients had significantly higher rates of positive reactions to ingredients in personal care products and topical medications, including fragrance mix II ($P=0.04$), lanolin ($P=0.03$), bacitracin ($P=0.04$), cinnamal ($P=0.02$), budesonide ($P=0.01$), tixocortol ($P=0.02$), and chlorhexidine ($P=0.001$); relevance was established in $>90\%$ of these reactions. Polysensitization occurred more commonly in patients with vs. without AD (35 [32.4%] vs. 75 [19.0%], $P=0.01$).

Limitations: Study performed at a single center.

Conclusion: AD patients had more positive patch test reactions to ingredients in personal care products, topical steroids and antibiotics.

INTRODUCTION:

AD is associated with skin-barrier disruption, increased skin absorption of irritants and contact allergens¹⁻³, and application of topical emollients and medications, many of which may contain known contact sensitizers^{4,5}. These may increase the risk of ACD in AD patients. However, AD is also associated with T helper 2 inflammatory responses⁶, and increased elicitation threshold to potent allergens⁶⁻⁹, which decrease ACD risk.

Recent studies suggest that ACD is more common in AD patients, with higher rates of reactions to ingredients commonly found in personal care products and topical medications¹⁰. However, a recent systematic review and meta-analysis found that AD was not associated with higher odds of ACD overall¹¹. Interpretation of previous studies is complicated by lack of a standardized definition of AD, no differentiation between current or past history of AD, use of limited patch testing series, and no differentiation between the strength of the patch test reactions. We sought to examine the relationship between AD and ACD, while addressing these issues. Other questions remain about the relationship between AD and ACD, including the profile of relevant allergens and rates of polysensitization. We hypothesized that AD is associated with a distinct profile of and higher rates of polysensitization to contact allergens. In this study, we examined the complex relationship of AD and ACD.

METHODS:*Study design*

We performed a retrospective chart review of 502 adults (age ≥ 18 years), who were patch tested at the Northwestern Medicine patch-testing clinic from 2014-2017. Patients routinely completed a questionnaire that assessed demographics and historical elements related to the diagnosis of their AD. Patients also underwent history and physical examination by a dermatologist (JS) prior to patch testing. Distribution of skin lesions was recorded for each patient. Patients were patch-tested with the North American Contact Dermatitis Group (NACDG) standard and expanded series. The expanded series contains supplemental allergens beyond what is included in the standard series to allow for a more complete evaluation. Patches were applied to patient's upper back and removed after 48 hours. Patches were initially evaluated at 48 hours, and again at 72 hours where final patch test results were recorded. Negative reactions included weak or irritant responses. Positive reactions were further classified as +, ++, +++ per the International Contact Dermatitis Research Group's scoring system¹². Relevance was established by patient history, e.g. known or likely exposures, and/or improvement with allergen avoidance.

All data were stored in Research Data Capture Software (REDCap). The institutional review board of Northwestern University approved the study and informed consent was waived.

AD

Current AD was diagnosed using the Hanifin and Rajka criteria¹³. Past AD was defined as patient-reported past medical history of AD with no current disease per history and physical exam. Those without past or present AD were defined as non-AD controls.

108 *Statistical analysis*

109 All statistical analyses were performed using SAS version 9.4 (SAS Institute, Cary, NC).

110 Chi-square and Fisher exact tests were used to compare AD and positive reactions to contact
111 allergens. A two-sided P-value <0.05 was taken to indicate statistical significance. However, the
112 multiple dependent tests performed in this study increase the risk of falsely rejecting the null
113 hypothesis. Therefore, P-values near 0.05 should be interpreted with caution.

114 Multivariable multinomial logistic regression was performed to determine the association
115 between polysensitization (defined as ≥ 3 positive reactions) and AD. Adjusted odds ratios (aORs)
116 and 95% CIs were estimated. Sex (male/female), race (white/non-white), and age (younger than
117 40/40 and older) were included as covariables. An additional sensitivity analysis was performed to
118 correct for cross-reactors, which were identified using the American Contact Dermatitis Society
119 (ACDS) Contact Allergens Management Program database.

RESULTS:*Patient characteristics*

Overall, 502 adults (ages 18-84 years) were included in the study, including 381 women (77.0%) and 358 whites (71.3%) (Table 1). The mean $\pm$ standard deviation [SD] age at initial encounter was 47.1 ± 14.8 years. Current AD was diagnosed in 108 (21.5%) individuals, including 83 women (76.9%) and 65 whites (60.2%), with mean $\pm$ SD age at enrollment 44.4 ± 15.2 years. Past AD was diagnosed in 109 (34.3%) individuals, including 83 females (78.3%) and 80 whites (73.3%), with mean $\pm$ SD age at enrollment 44.4 ± 14.5 years. There were no significant differences in demographics between adults with current vs. past vs. no history of AD, except those with current AD were more likely to be non-white and age <40 years, and those with past AD were more likely to be age <40 years.

Contact allergen hypersensitivity

Similar proportions of any positive (+/++/+++): 80 [74.1%] vs. 254 [64.5%]; Chi-square, $P=0.06$), stronger (++/+++): 34 [31.5%] vs. 102 [25.9%], $P=0.25$) and irritant (56 [51.9%] vs. 188 [47.7%], $P=0.45$) reactions were found in those with vs. without current AD. Likewise, patients with past vs. no AD had similar proportions of any positive (+/++/+++): 72 [65.1%] vs. 137 [65.6%]; $P=0.94$), stronger (++/+++): 28 [25.7%] vs. 59 [28.2%], $P=0.63$) and irritant (50 [45.9%] vs. 102 [48.8%], $P=0.62$) reactions.

Adults with vs. without current AD had higher rates of positive patch test reactions (PPTR) to ingredients in their personal care products or topical medications, including bacitracin (7.4% vs. 3.0%, $P=0.04$), fragrance mix II (5.6% vs. 2.0%, $P=0.04$), lanolin (4.6% vs. 1.3%, $P=0.03$), cinnamal (3.7% vs. 0.8%, $P=0.02$), chlorhexidine (3.7% vs. 0.2%, $P=0.01$), tixocortol pivalate (3.7% vs. 0.8%,

P=0.02), and budesonide (1.8% vs. 0.0%, P=0.01) (Supplemental Table 2). Adults with past vs. no history of AD had significantly higher rates of PPTR to cinnamal (2.8% vs. 0%, P=0.04), cyanoacrylate (2.8% vs 0%, P=0.04), quaternium-15 (2.8% vs 0%, P=0.04), and lanolin (3.7% vs 0.5%, P=0.04).

Relevance was established in >90% of patients with positive reactions to one of these allergens, with exposures from emollients, cosmetics, soaps, shampoos and conditioners, topical corticosteroids, and antibiotics. Of note, weak/irritant reactions were observed for lanolin in current (1.9%) and past AD patients (3.7%), and virtually all such reactions were relevant. There were no significant differences in irritant reactions for nickel (current AD: 3.7% vs. 3.6%, P=0.94, past AD: 4.6% vs 3.8%, P=0.75), of for chromium (1.8% vs. 0.97%, P=0.51) and cobalt (0.92% vs 0.96%, P=0.97) in those with *past* vs. no AD. However, there were significant differences in irritant reactions for chromium (3.7% vs. 1.0%, P=0.048) and cobalt (3.7% vs. 0.8%, P=0.02) in those with vs. without *current* AD.

Among females, PPTR to budesonide (2.4%, P=0.007) and chlorhexidine (4.8%, P=0.002) were associated with current AD. Among whites, current AD was significantly associated with positive reactions to lanolin (4.6%, P=0.01), budesonide (3.1%, P=0.003), and chlorhexidine (4.6%, P=0.0002), while cinnamal (7.0%, P=0.04) was associated with current AD in non-whites. In those age ≥ 40 years, bacitracin (10.3%, P=0.03) and cinnamal (3.5%, P=0.03) were associated with current AD. However, among those <40 years, lanolin (6.0%, P=0.03) and budesonide (4.0%, P=0.02) were associated with current AD.

Distribution of skin lesions

The distribution of skin lesions differed between those with current vs. past vs. no history of AD (Figure 1). Eyelids (39.4%) were the most common sites of skin lesions in those without a history of AD, whereas the arms (58.8%) were the most commonly affected sites in those with current and past AD. Lesions on the arms were associated with having a PPTR among patients with current ($P=0.02$) and past AD ($P=0.02$). Lesions on the back were associated with a positive reaction among those without current ($P=0.04$) and past AD ($P=0.02$).

Polysensitization

Overall, polysensitization (≥ 3 PPTR) occurred in 110 (21.9%) adults. Polysensitization occurred more frequently in adults with vs. without current AD (35 [32.4%] vs. 75 [19.0%]; Chi square, $P=0.01$). In multivariable multinomial logistic regression models, polysensitization was associated with current AD (aOR [95% CI]: 2.13 [1.31-3.48]), inversely associated with female sex (0.58 [0.36-0.94]), but not associated with age (1.32 [0.83-2.11]) or non-white race/ethnicity (1.06 [0.66-1.71]). Rates of polysensitization did not significantly differ in those with past vs. no history of AD (22 [21.1%] vs. 38 [18.2%]; Chi square, $P=0.78$). Polysensitization remained significantly associated with female sex (0.47 [0.25-0.90]), but not with past AD (1.15 [0.63-2.09]), age (1.03 [0.56-1.89]), or non-white race/ethnicity (1.12 [0.60-2.10]) in multivariable analyses.

A sensitivity analysis was performed using a modified definition that corrected for cross-reactors. The frequency of patients meeting this definition of polysensitization decreased to 88 (17.5%), overall, with significantly higher rates still observed in those with vs. without current AD (31 [28.7%] vs. 57 [14.5%], $P=0.002$), but similar rates seen between those with past vs. no history of AD (17 [15.6%] vs. 28 [13.4%] $P=0.84$). Multivariable multinomial logistic regression models showed that polysensitization remained associated with current AD (aOR [95% CI]: 2.56 [1.52-

188 4.31]), inversely associated with female sex (0.57 [0.34-0.96]), but not associated with age (1.51
189 [0.90-2.54]) or non-white race/ethnicity (1.08 [0.90-2.54]). Polysensitization was not associated with
190 female sex (0.51 [0.25-1.05]), past AD (1.16 [0.59-2.29]), age (1.39 [0.68-2.82]), or non-white
191 race/ethnicity (1.11 [0.55-2.27]) in multivariable models after correcting for cross-reactors.

DISCUSSION:

This study found a complex relationship between AD and ACD. Overall, there were no differences in PPTR between those with current, past history or no AD. These results are consistent with a meta-analysis of 56 studies with a baseline screening series that found no statistical difference of contact sensitization between persons with vs. without AD overall¹¹. However, there was an association between AD and contact sensitization in pooled analysis of 5 studies from the general population, albeit with a modest effect-size¹¹. Together, AD patients do not appear to have higher rates of contact sensitization compared with other patients who were patch tested in the clinical setting. Future population-based studies are needed to confirm the association and identify the risk factors for an association between AD and contact sensitization.

Adults with current and past AD had significantly higher rates of positive and relevant patch test reactions to ingredients in their personal care products and topical medications. Similarly, analysis of a registry of patch testing results from 1142 children across the US found that children with AD had more positive reactions to cocamidopropyl betaine, lanolin, and tixocortol pivalate¹⁴. Another study patch tested 641 French children with AD to their current emollient and six common topical treatments⁵. PPTR were observed in 6.2%, most commonly to their emollient and chlorhexidine. Risk factors associated with contact sensitization to their AD treatment, included AD onset before 6 years of age⁵, IgE-mediated sensitization⁵, and moderate to severe AD^{5, 15}. We found higher rates of PPTR to chlorhexidine and bacitracin in current AD and neomycin in past AD. All three of these agents are available over-the-counter in the US, and are still commonly used as adjunctive AD treatments (unpublished data) despite not being recommended¹⁶. Given previously found increased risk of anti-biotic resistance¹⁷, and higher rates of PPTR, routine use of topical anti-biotics should be discouraged. We also found more PPTR to fragrances, which are present in myriad

personal care products. AD patients may benefit from proactive avoidance of fragrances to reduce sensitization risk.

Current AD was associated with allergen polysensitization, even after correcting for cross-reactors. Polysensitization was not increased in past AD patients, suggesting that ongoing disease is a risk factor for polysensitization. While we excluded weak reactions due to irritancy, it is possible that patients with active AD have exuberant irritant or false-positive reactions. Though, we did not find any significant difference of actual irritant reactions between those with or without AD. A previous questionnaire-based case-control study of 562 polysensitized (≥ 3 PPTR) and 1124 mono/double-sensitized individuals found that 45.1% vs. only 31% reported having AD, respectively¹⁸.

Female sex was inversely associated with polysensitization in multivariable regression models. This result differs from previous studies that reported female sex as a risk factor for ACD¹⁹ and polysensitization²⁰. One explanation for these differences is that we controlled for AD history, which is associated with polysensitization. Future studies examining the associations of ACD and polysensitization should consider multivariable models that control for potential confounding variables. Despite the inverse association between female sex and polysensitization, we found that AD was associated with a distinct profile of PPTR, e.g. chlorhexidine and budesonide. We also found racial/ethnic and age differences for PPTR among AD patients. Previous studies from the NACDG found differences in the PPTR allergen profile by race^{21, 22} and age²³. Observed racial and age differences among AD patients may reflect broader differences in allergen profiles by socio-demographics and other risk factors.

The only lesional distribution significantly associated with allergen hypersensitivity was the presence of lesions on the arms. However, this may be related to arms having been the most common site of eczematous lesions among AD patients overall.

There is a complex relationship between current AD and ACD, with potentially overlapping mechanisms, symptoms, lesional morphology and distribution. A recent multi-disciplinary consensus guidelines recommended patch testing in AD patients with dermatitis that worsens or fails to improve with topical therapy, has an atypical or changing distribution, adult- or adolescent-onset AD, or severe dermatitis prior to starting systemic immunosuppressants²⁴. Presence of nummular eczematous lesions is also a consideration for patch testing in AD patients²⁵. There is currently insufficient evidence to support the use of a particular screening panel. However, it has been suggested to use an expanded screening series, such as the ACDS core or NACDG standard series, since many of the relevant allergens in AD patients are not present in the T.R.U.E test²⁵. AD patients may experience additional benefit from routine testing to chlorhexidine. Finally, caution should be taken when interpreting patch test results in AD patients. Previous reports suggested that AD patients more frequently have irritant reactions to nickel, cobalt, chromate, and lanolin, which can result in false positives²⁶. We did not find a significant difference in irritant reactions in past vs. no AD patients, but did find patients with current AD were more likely to have irritant reactions to cobalt and chromates, in particular. Lanolin was indeed associated with higher rates of weak/irritant reactions, and was almost always relevant. Patients with severe or uncontrolled AD may also have diminished contact sensitivity leading to false negatives²⁷.

This study has several strengths, including use of a standardized AD definition, expanded patch test series, sensitivity analyses by the strength of patch test reactions, and evaluation of

258 polysensitization. However, all patch testing was performed at a single academic center and results
259 may not be generalizable to all adults with AD.

260 In conclusion, current and past AD patients had higher rates of ACD to multiple ingredients
261 in their personal care products and topical medications. Future studies are underway to determine the
262 impact of contact allergen avoidance on the clinical course and severity of AD.

References:

1. Thyssen JP , Kezic S. Causes of epidermal filaggrin reduction and their role in the pathogenesis of atopic dermatitis. *The Journal of allergy and clinical immunology* 2014;134:792-9.
2. Jakasa I, de Jongh CM, Verberk MM, Bos JD , Kezic S. Percutaneous penetration of sodium lauryl sulphate is increased in uninvolved skin of patients with atopic dermatitis compared with control subjects. *The British journal of dermatology* 2006;155:104-9.
3. Halling-Overgaard AS, Kezic S, Jakasa I, Engebretsen KA, Maibach H , Thyssen JP. Skin absorption through atopic dermatitis skin: a systematic review. *The British journal of dermatology* 2017;177:84-106.
4. Hamann CR, Bernard S, Hamann D, Hansen R , Thyssen JP. Is there a risk using hypoallergenic cosmetic pediatric products in the United States? *The Journal of allergy and clinical immunology* 2015;135:1070-1.
5. Mailhol C, Lauwers-Cances V, Rance F, Paul C , Giordano-Labadie F. Prevalence and risk factors for allergic contact dermatitis to topical treatment in atopic dermatitis: a study in 641 children. *Allergy* 2009;64:801-6.
6. Uehara M , Sawai T. A longitudinal study of contact sensitivity in patients with atopic dermatitis. *Archives of dermatology* 1989;125:366-8.
7. Uehara M , Ofuji S. Patch test reactions to human dander in atopic dermatitis. *Archives of dermatology* 1976;112:951-4.
8. Jones HE, Lewis CW , McMarlin SL. Allergic contact sensitivity in atopic dermatitis. *Archives of dermatology* 1973;107:217-22.
9. Forsbeck M, Hovmark A , Skog E. Patch testing, tuberculin testing and sensitization with dinitrochlorobenzene and nitrosodimethylanilini of patients with atopic dermatitis. *Acta dermato-venereologica* 1976;56:135-8.
10. Malajian D , Belsito DV. Cutaneous delayed-type hypersensitivity in patients with atopic dermatitis. *Journal of the American Academy of Dermatology* 2013;69:232-7.
11. Hamann CR, Hamann D, Egeberg A, Johansen JD, Silverberg J , Thyssen JP. Association between atopic dermatitis and contact sensitization: A systematic review and meta-analysis. *Journal of the American Academy of Dermatology* 2017;77:70-8.
12. Fonacier L, Bernstein DI, Pacheco K, Holness DL, Blessing-Moore J, Khan D et al. Contact dermatitis: a practice parameter-update 2015. *The journal of allergy and clinical immunology In practice* 2015;3:S1-39.
13. Hanifin JM , G. R. Diagnostic features of atopic dermatitis. *Acta Derm Venereol Suppl* (Stockh) 1980;92:44-7.
14. Jacob SE, McGowan M, Silverberg NB, Pelletier JL, Fonacier L, Mousdicas N et al. Pediatric Contact Dermatitis Registry Data on Contact Allergy in Children With Atopic Dermatitis. *JAMA dermatology* 2017;153:765-70.
15. Herro EM, Matiz C, Sullivan K, Hamann C , Jacob SE. Frequency of contact allergens in pediatric patients with atopic dermatitis. *The Journal of clinical and aesthetic dermatology* 2011;4:39-41.
16. Eichenfield LF, Tom WL, Berger TG, Krol A, Paller AS, Schwarzenberger K et al. Guidelines of care for the management of atopic dermatitis: Section 2. Management and treatment of atopic dermatitis with topical therapies. *Journal of the American Academy of Dermatology* 2014;71:116-32.

17. Bessa GR, Quinto VP, Machado DC, Lipnharski C, Weber MB, Bonamigo RR et al. Staphylococcus aureus resistance to topical antimicrobials in atopic dermatitis. *An Bras Dermatol* 2016;91:604-10.
18. Carlsen BC, Andersen KE, Menne T, Johansen JD. Characterization of the polysensitized patient: a matched case-control study. *Contact dermatitis* 2009;61:22-30.
19. Modjtahedi BS, Modjtahedi SP, Maibach HI. The sex of the individual as a factor in allergic contact dermatitis. *Contact dermatitis* 2004;50:53-9.
20. Schwitulla J, Gefeller O, Schnuch A, Uter W. Risk factors of polysensitization to contact allergens. *The British journal of dermatology* 2013;169:611-7.
21. Deleo VA, Alexis A, Warshaw EM, Sasseville D, Maibach HI, DeKoven J et al. The Association of Race/Ethnicity and Patch Test Results: North American Contact Dermatitis Group, 1998-2006. *Dermatitis : contact, atopic, occupational, drug : official journal of the American Contact Dermatitis Society, North American Contact Dermatitis Group* 2016;27:288-92.
22. Deleo VA, Taylor SC, Belsito DV, Fowler JF, Jr., Fransway AF, Maibach HI et al. The effect of race and ethnicity on patch test results. *Journal of the American Academy of Dermatology* 2002;46:S107-12.
23. Warshaw EM, Raju SI, Fowler JF, Jr., Maibach HI, Belsito DV, Zug KA et al. Positive patch test reactions in older individuals: retrospective analysis from the North American Contact Dermatitis Group, 1994-2008. *Journal of the American Academy of Dermatology* 2012;66:229-40.
24. Chen JK, Jacob SE, Nedorost ST, Hanifin JM, Simpson EL, Boguniewicz M et al. A Pragmatic Approach to Patch Testing Atopic Dermatitis Patients: Clinical Recommendations Based on Expert Consensus Opinion. *Dermatitis : contact, atopic, occupational, drug : official journal of the American Contact Dermatitis Society, North American Contact Dermatitis Group* 2016;27:186-92.
25. Owen JL, Vakharia PP, Silverberg JI. The Role and Diagnosis of Allergic Contact Dermatitis in Patients with Atopic Dermatitis. *American journal of clinical dermatology* 2018.
26. de Waard-van der Spek FB, Darsow U, Mortz CG, Orton D, Worm M, Muraro A et al. EAACI position paper for practical patch testing in allergic contact dermatitis in children. *Pediatric allergy and immunology : official publication of the European Society of Pediatric Allergy and Immunology* 2015;26:598-606.
27. Spiewak R. Contact dermatitis in atopic individuals. *Current opinion in allergy and clinical immunology* 2012;12:491-7.

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Figure Legends.

Figure 1. Distribution of skin lesions among patients with (A) current, (B) past and (C) no history of AD. Frequency (%) of skin lesions are presented for each body part. Statistically significant associations with having a positive patch test reaction are indicated in bold face.

Table 1. Subject characteristics.			
Variable	Atopic dermatitis		
	No history	Past history	Current history
	Frequency (%)	Frequency (%)	Frequency (%)
Age (years)			
Younger than 40	67 (32.4%)	48 (44.9%)	50 (46.3%)
40 and Older	140 (67.6%)	59 (55.1%)	58 (53.7%)
Sex			
Female	166 (80.2%)	83 (78.3%)	83 (76.9%)
Male	41 (19.8%)	23 (21.7%)	25 (23.1%)
Race/ethnicity			
White	151 (72.3%)	80 (73.4%)	60 (61.9%)
Non-white	58 (27.7%)	29 (26.6%)	37 (38.1%)
Birthplace			
Born in US	164 (80.0%)	92 (86.8%)	79 (86.8%)
Born outside US	41 (20.0%)	14 (13.2%)	12 (13.2%)

355 <1% of patient data missing for age and sex, <3% patient data missing for birthplace

Supplemental Table 1. Association of current and past atopic dermatitis with contact hypersensitivity.						
Allergen	Current atopic dermatitis			Past atopic dermatitis		
	No (n=394)	Yes (n=108)	P*	No (n=209)	Yes (n=109)	P*
	Freq (%)	Freq (%)		Freq (%)	Freq (%)	
Benzocaine, 5.0% pet						
Negative	392 (99.5%)	107 (99.1%)	0.52	208 (99.5%)	109 (100%)	0.99
Positive	2 (0.5%)	1 (0.9%)		1 (0.5%)	0 (0%)	
2-Mercaptobenzothiazole, 1.0% pet						
Negative	391 (99.2%)	108 (100%)	0.99	207 (99.0%)	108 (99.1%)	0.99
Positive	3 (0.8%)	0 (0%)		2 (1.0%)	1 (0.9%)	
Colophonium, (Rosin) 20.0% pet						
Negative	393 (99.8%)	107 (99.1%)	0.38	208 (99.5%)	109 (100%)	0.99
Positive	1 (0.2%)	1 (0.9%)		1 (0.5%)	0 (0%)	
4-Phenylenediamine base, 1.0% pet						
Negative	377 (95.7%)	107 (99.1%)	0.14	202 (96.7%)	103 (94.5%)	0.36
Positive	17 (4.3%)	1 (0.9%)		7 (3.3%)	6 (5.5%)	
Dimethylaminopropylamine, (DMAPA) 1.0% aq						
Negative	387 (98.2%)	108 (100%)	0.36	205 (98.1%)	106 (97.3%)	0.69
Positive	7 (1.8%)	0 (0%)		4 (1.9%)	3 (2.7%)	
Fragrance Mix II, 14.0% pet						
Negative	386 (98.0%)	102 (94.4%)	0.04	204 (97.6%)	106 (97.3%)	0.99
Positive	8 (2.0%)	6 (5.6%)		5 (2.4%)	3 (2.7%)	
Lanolin alcohol (Amerchol L101), 50% pet						
Negative	389 (98.7%)	103 (95.4%)	0.03	208 (99.5%)	105 (96.3%)	0.04
Positive	5 (1.3%)	5 (4.6%)		1 (0.5%)	4 (3.7%)	
Carba Mix, 3.0% pet						
Negative	380 (96.5%)	106 (98.2%)	0.54	201 (96.2%)	104 (95.4%)	0.75
Positive	14 (3.5%)	2 (1.8%)		8 (3.8%)	5 (4.6%)	
Neomycin Sulfate, 20.0% pet						
Negative	388 (98.5%)	103 (95.4%)	0.05	208 (99.5%)	105 (96.3%)	0.04
Positive	6 (1.5%)	5 (4.6%)		1 (0.5%)	4 (3.7%)	
Thiuram Mix, 1.0% pet						
Negative	389 (98.7%)	106 (98.2%)	0.65	207 (99.0%)	107 (98.2%)	0.61
Positive	5 (1.3%)	2 (1.8%)		2 (1.0%)	2 (1.8%)	
Formaldehyde, 1.0% aq						
Negative	373 (94.7%)	105 (97.2%)	0.44	202 (96.7%)	100 (91.7%)	0.06
Positive	21 (5.3%)	2 (2.8%)		7 (3.3%)	9 (8.3%)	
Ethylenediamine Dihydrochloride, 1.0% pet						
Negative	390 (99.0%)	107 (99.1%)	0.99	208 (99.5%)	109 (100%)	0.99
Positive	4 (1.0%)	1 (0.9%)		1 (0.5%)	0 (0%)	
Bisphenol A epoxyn resin , 1.0% pet						
Negative	391 (99.2%)	108 (100%)	0.99	206 (98.6%)	109 (100%)	0.55

Positive	3 (0.7%)	0 (0%)		3 (1.4%)	0 (0%)	
Quaternium-15, 2.0% pet						
Negative	390 (99.0%)	104 (96.3%)	0.07	209 (100%)	106 (97.3%)	0.04
Positive	4 (1.0%)	4 (3.7%)		0 (0%)	3 (2.7%)	
Ethylhexylglycarin, 5% pet						
Negative	394 (100%)	108 (100%)	N/A	209 (100%)	109 (100%)	N/A
Positive	0 (0%)	0 (0%)		0 (0%)	0 (0%)	
Black Rubber Mix, 0.6% pet						
Negative	391 (99.2%)	106 (98.2%)	0.29	208 (99.5%)	109 (100%)	0.99
Positive	3 (0.8%)	2 (1.8%)		1 (0.5%)	0 (0%)	
Potassium Dichromate, 0.25% pet						
Negative	383 (97.2%)	102 (94.4%)	0.16	200 (95.7%)	107 (98.2%)	0.34
Positive	11 (2.8%)	6 (5.6%)		9 (4.3%)	2 (1.8%)	
Myroxylon Pareirae Resin (Balsam of Peru), 25.0% pet						
Negative	346 (87.8%)	98 (90.7%)	0.4	183 (87.6%)	97 (89.0%)	0.71
Positive	48 (12.2%)	10 (9.3%)		26 (12.4%)	12 (11.0%)	
Nickel Sulfate Hexahydrate, 25% pet						
Negative	328 (83.3%)	95 (88.0%)	0.23	173 (82.8%)	92 (84.4%)	0.71
Positive	66 (16.7%)	13 (12.0%)		36 (17.2%)	17 (15.6%)	
Diazolidinyl Urea (Germall II), 1.0% pet						
Negative	393 (99.8%)	107 (99.1%)	0.38	209 (100%)	108 (99.1%)	0.34
Positive	1 (0.2%)	1 (0.9%)		0 (0%)	1 (0.9%)	
DMDM Hydantoin (Germall 115) 1.0% pet						
Negative	391 (99.2%)	108 (100%)	0.99	208 (99.5%)	107 (98.2%)	0.27
Positive	3 (0.8%)	0 (0%)		1 (0.5%)	2 (1.8%)	
Imidazolldinyl Urea 2.0% pet						
Negative	390 (99.2%)	107 (99.1%)	0.99	206 (99.0%)	108 (99.1%)	0.99
Positive	3 (0.8%)	1 (0.9%)		2 (1.0%)	1 (0.9%)	
Bacitracin, 20.0% pet						
Negative	382 (97.0%)	100 (92.6%)	0.04	203 (97.1%)	107 (98.2%)	0.72
Positive	12 (3.0%)	8 (7.4%)		6 (2.9%)	2 (1.8%)	
Mixed Dialkyl Thioureas, 1.0% pet						
Negative	389 (98.7%)	108 (100%)	0.6	205 (98.1%)	108 (99.1%)	0.66
Positive	5 (1.3%)	0 (0%)		4 (1.9%)	1 (0.9%)	
Methylchloroisothiasolinone/methylisothiasolinone, 0.01%						
Negative	375 (95.2%)	101 (93.5%)	0.49	198 (94.7%)	106 (97.3%)	0.40
Positive	19 (4.8%)	7 (6.5%)		11 (5.3%)	3 (2.7%)	
Paraben Mix, 12.0% pet						
Negative	393 (99.8%)	108 (100%)	0.99	208 (99.5%)	109 (100%)	0.99
Positive	1 (0.2%)	0 (0%)		1 (0.5%)	0 (0%)	
Cinnamal (Cinnamic Aldehyde) 1.0% pet						
Negative	391 (99.2%)	104 (96.3%)	0.04	209 (100%)	106 (97.3%)	0.04
Positive	3 (0.8%)	3 (3.7%)		0 (0%)	3 (2.7%)	
Fragrance Mix I 8.0% pet						
Negative	363 (92.1%)	101 (93.5%)	0.63	191 (91.4%)	99 (90.8%)	0.87

Positive	31 (7.9%)	7 (6.5%)		18 (8.6%)	10 (9.2%)	
Amidoamine (Stearamidopropyl Dimethylamine), 0.1% aq						
Negative	393 (99.8%)	106 (98.2%)	0.12	209 (100%)	108 (99.1%)	0.34
Positive	1 (0.2%)	2 (1.8%)		0 (0%)	1 (0.9%)	
2-Bromo-2-Nitropropane-1,3-diol (Bronopol), 0.5% pet						
Negative	390 (99.0%)	106 (98.2%)	0.62	207 (99.0%)	108 (99.1%)	0.99
Positive	4 (1.0%)	2 (1.8%)		2 (1.0%)	1 (0.9%)	
Sesquiterpenelactone Mix, 0.1% pet						
Negative	394 (100%)	108 (100%)	N/A	209 (100%)	109 (100%)	N/A
Positive	0 (0%)	0 (0%)		0 (0%)	0 (0%)	
2-Hydroxyethyl Methacrylate, 2.0% pet						
Negative	388 (98.5%)	106 (98.2%)	0.68	209 (100%)	108 (99.1%)	0.66
Positive	6 (1.5%)	2 (1.8%)		0 (0%)	1 (0.9%)	
Propylene Glycol, 30.0% aq						
Negative	387 (98.2%)	103 (95.4%)	0.09	203 (97.1%)	108 (99.1%)	0.43
Positive	7 (1.8%)	5 (4.6%)		6 (2.9%)	1 (0.9%)	
Benzophenone-3 (Oxybenzone or 2-hydroxy-4-Methoxy-						
Negative	394 (100%)	108 (100%)	N/A	209 (100%)	109 (100%)	N/A
Positive	0 (0%)	0 (0%)		0 (0%)	0 (0%)	
Chloroxylonol (4-Chloro-3,5-xylene), 1.0% pet						
Negative	391 (99.2%)	106 (98.2%)	0.29	208 (99.5%)	109 (100%)	0.99
Positive	3 (0.8%)	2 (1.8%)		1 (0.5%)	0 (0%)	
Parthenolide, 0.1% pet						
Negative	392 (99.5%)	108 (100%)	0.99	207 (99.0%)	109 (100%)	0.99
Positive	2 (0.5%)	0 (0%)		2 (1.0%)	0 (0%)	
Methylisothiazolinone, 0.2% aq						
Negative	359 (91.1%)	101 (93.5%)	0.42	190 (90.9%)	101 (92.7%)	0.60
Positive	35 (8.9%)	7 (6.5%)		19 (9.1%)	8 (7.3%)	
Desoximetasone, 1.0% pet						
Negative	392 (99.5%)	107 (99.1%)	0.52	207 (99.0%)	109 (100%)	0.55
Positive	2 (0.5%)	1 (0.9%)		2 (1.0%)	0 (0%)	
Methyldibromo Glutaronitrile/Phenoxyethanol,						
Negative	382 (97.0%)	104 (96.3%)	0.76	203 (97.1%)	105 (96.3%)	0.74
Positive	12 (3.0%)	4 (3.7%)		6 (2.9%)	4 (3.7%)	
Diphenylguanidine, 1% pet						
Negative	381 (96.7%)	103 (95.4%)	0.51	203 (97.1%)	106 (97.3%)	0.99
Positive	13 (3.3%)	5 (4.6%)		6 (2.9%)	3 (2.7%)	
Tocopherol (DL- α - Tocopherol), 100.0%						
Negative	392 (99.5%)	108 (100%)	0.99	207 (99.0%)	109 (100%)	0.55
Positive	2 (0.5%)	0 (0%)		2 (1.0%)	0 (0%)	
Iodopropynyl Butylcarbamate, 0.5% pet						
Negative	372 (94.4%)	102 (94.4%)	0.99	197 (94.3%)	103 (94.5%)	0.93
Positive	22 (5.6%)	6 (5.6%)		12 (5.7%)	6 (5.5%)	
Ethyl Acrylate, 0.1% pet						
Negative	391 (99.2%)	106 (98.2%)	0.99	208 (99.5%)	107 (98.2%)	0.27

Positive	3 (0.8%)	2 (1.8%)		1 (0.5%)	2 (1.8%)	
Benzophenone-4 (Suliasobenzone), 10% pet						
Negative	388 (98.5%)	107 (99.1%)	0.99	205 (98.1%)	107 (98.2%)	0.99
Positive	6 (1.5%)	1 (0.9%)		4 (1.9%)	2 (1.8%)	
Tosylamide/ Formaldehyde resin, 10.0% pet						
Negative	392 (99.5%)	108 (100%)	0.99	208 (99.5%)	108 (99.1%)	0.99
Positive	2 (0.5%)	0 (0%)		1 (0.5%)	1 (0.9%)	
Methyl metacrylate, 2.0% pet						
Negative	392 (99.5%)	107 (99.1%)	0.52	207 (99.0%)	109 (100%)	0.55
Positive	2 (0.5%)	1 (0.95%)		2 (1.0%)	0 (0%)	
Cobalt (II) Chloride Hexahydrate, 1.0% pet						
Negative	379 (96.2%)	104 (96.3%)	0.99	201 (96.2%)	105 (96.3%)	0.99
Positive	15 (3.8%)	4 (3.7%)		8 (3.8%)	4 (3.7%)	
Tixocortol-21-pivalate, 1.0% pet						
Negative	391 (99.2%)	104 (96.3%)	0.04	207 (99.0%)	108 (99.1%)	0.99
Positive	3 (0.8%)	4 (3.7%)		2 (1.0%)	1 (0.9%)	
Budesonide, 0.1% pet						
Negative	394 (100%)	106 (98.2%)	0.04	209 (100%)	109 (100%)	N/A
Positive	0 (0%)	2 (1.8%)		0 (0%)	0 (0%)	
Hydrocortisone-17-butyrate, 1% pet						
Negative	394 (100%)	107 (99.1%)	0.06	209 (100%)	109 (100%)	N/A
Positive	0 (0%)	1 (0.9%)		0 (0%)	0 (0%)	
Disperse blue mix 124/106, 1.0% pet						
Negative	392 (99.5%)	107 (99.1%)	0.52	209 (100%)	108 (99.1%)	0.34
Positive	2 (0.5%)	1 (0.9%)		0 (0%)	1 (0.9%)	
Propolis, 10.0% pet						
Negative	386 (97.8%)	105 (97.2%)	0.71	205 (98.1%)	107 (98.2%)	0.99
Positive	8 (2.2%)	3 (2.8%)		4 (1.9%)	2 (1.8%)	
Lidocaine-HCl, 15.0% pet						
Negative	393 (99.8%)	108 (100%)	0.99	208 (99.5%)	109 (100%)	0.99
Positive	1 (0.2%)	0 (0%)		1 (0.5%)	0 (0%)	
Propylene glycol, 100% aq						
Negative	387 (98.2%)	103 (95.4%)	0.09	204 (97.6%)	107 (98.2%)	0.99
Positive	7 (1.8%)	5 (4.6%)		5 (2.4%)	2 (1.8%)	
Clobetasol-17-propionate, 1.0% pet						
Negative	394 (100%)	108 (100%)	N/A	209 (100%)	109 (100%)	N/A
Positive	0 (0%)	0 (0%)		0 (0%)	0 (0%)	
Cocamidopropyl betaine, 1.0 aq						
Negative	392 (99.5%)	106 (98.2%)	0.2	208 (99.5%)	109 (100%)	0.99
Positive	2 (0.5%)	2 (1.8%)		1 (0.5%)	0 (0%)	
Oleamidopropyl dimethylamine 0.1% aq						
Negative	382 (97.0%)	108 (100%)	0.08	202 (96.6%)	106 (97.3%)	0.99
Positive	12 (3.0%)	0 (0%)		7 (3.4%)	3 (2.7%)	
Ethyl 2-cyanoacrylate, 10.0% pet						
Negative	391 (99.2%)	106 (98.2%)	0.29	209 (100%)	106 (97.3%)	0.04

Positive	3 (0.8%)	2 (1.8%)		0 (0%)	3 (2.7%)	
Cocamide DEA (Coconut diethanolamide) 0.5% pet						
Negative	388 (98.5%)	107 (99.1%)	0.99	204 (97.6%)	109 (100%)	0.17
Positive	6 (1.5%)	1 (0.9%)		5 (2.4%)	0 (0%)	
Compositae mix, 6.0% pet						
Negative	391 (99.2%)	108 (100%)	0.99	208 (99.5%)	108 (99.1%)	0.99
Positive	3 (0.8%)	0 (0%)		1 (0.5%)	1 (0.9%)	
Glutaral, 1.0% pet						
Negative	389 (98.7%)	107 (99.1%)	0.99	206 (98.6%)	108 (99.1%)	0.99
Positive	5 (1.3%)	1 (0.9%)		3 (1.4%)	1 (0.9%)	
Melaleuca Altemifolla, (tea tree leaf oil), oxidized, 5.0% pet						
Negative	393 (99.8%)	108 (100%)	0.99	209 (100%)	109 (100%)	N/A
Positive	1 (0.2%)	0 (0%)		0 (0%)	0 (0%)	
Cananga Odorata Flower oil (yiang-yiang oil), 2.0% pet						
Negative	392 (99.5%)	108 (100%)	0.99	207 (99.0%)	109 (100%)	0.55
Positive	2 (0.5%)	0 (0%)		2 (1.0%)	0 (0%)	
Carvone, 5.0% pet						
Negative	394 (100%)	108 (100%)	N/A	209 (100%)	109 (100%)	N/A
Positive	0 (0%)	0 (0%)		0 (0%)	0 (0%)	
Lavandula Angustifolla oil. (lavander oil) 2.0% pet						
Negative	394 (100%)	108 (100%)	N/A	209 (100%)	109 (100%)	N/A
Positive	0 (0%)	0 (0%)		0 (0%)	0 (0%)	
Decyl glucoside, 5.0% pet						
Negative	391 (99.2%)	105 (97.2%)	0.12	207 (99.0%)	108 (99.1%)	0.99
Positive	3 (0.8%)	2 (2.8%)		2 (1.0%)	1 (0.9%)	
Jasminum Officinale oil (jasminum grandiflorum), 2.0%						
Negative	394 (100%)	108 (100%)	N/A	209 (100%)	109 (100%)	N/A
Positive	0 (0%)	0 (0%)		0 (0%)	0 (0%)	
Mantha Piperita oil (peppermint oil), 2.0% pet						
Negative	393 (99.8%)	108 (100%)	0.99	208 (99.5%)	109 (100%)	0.99
Positive	1 (0.2%)	0 (0%)		1 (0.5%)	0 (0%)	
Benzoyl Peroxide, 1% pet						
Negative	381 (96.7%)	105 (97.2%)	0.99	200 (95.7%)	105 (96.3%)	0.99
Positive	13 (3.3%)	3 (2.8%)		9 (4.3%)	4 (3.7%)	
Diamino Diphenyl methane, 2.0% pet						
Negative	389 (98.7%)	107 (99.1%)	0.99	207 (99.0%)	108 (99.1%)	0.99
Positive	5 (1.3%)	1 (0.9%)		2 (1.0%)	1 (0.9%)	
Chlorhexidine Digluconate, 0.5% aq						
Negative	393 (99.8%)	104 (96.3%)	0.01	209 (100%)	108 (99.1%)	0.34
Positive	1 (0.2%)	3 (3.7%)		0 (0%)	1 (0.9%)	
Benzalkonium Chloride						
Negative	390 (99.0%)	106 (98.2%)	0.61	209 (100%)	107 (98.2%)	0.12
Positive	4 (1.0%)	2 (1.8%)		0 (0%)	2 (1.8%)	
Eugenol, 1% pet						
Negative	393 (99.8%)	108 (100%)	0.99	209 (100%)	108 (99.1%)	0.34

Positive	1 (0.2%)	0 (0%)		0 (0%)	1 (0.9%)	
Gold Sodium thiosulfate						
Negative	364 (94.5%)	97 (93.3%)	0.62	189 (93.1%)	101 (95.3%)	0.45
Positive	21 (5.5%)	7 (6.7%)		14 (6.9%)	5 (4.7%)	
Octyl Methoxycinnamate, 7.5% pet						
Negative	392 (99.5%)	107 (99.1%)	0.52	209 (100%)	108 (99.1%)	0.34
Positive	2 (0.5%)	1 (0.9%)		0 (0%)	1 (0.9%)	
Urea Formaldehyde						
Negative	390 (99.0%)	107 (99.1%)	0.99	207 (99.0%)	107 (98.2%)	0.61
Positive	4 (1.0%)	1 (0.9%)		2 (1.0%)	2 (1.8%)	
Dust Mite						
Negative	253 (64.2%)	75 (69.4%)	0.36	125 (59.8%)	81 (74.3%)	0.01
Positive	141 (35.8%)	33 (30.6%)		84 (40.2%)	28 (25.7%)	
Dimethylaminopropylamine, 1% pet						
Negative	384 (97.5%)	107 (99.1%)	0.47	205 (98.1%)	106 (97.3%)	0.69
Positive	10 (2.5%)	1 (0.9%)		4 (1.9%)	3 (2.7%)	
Methylene-Gamma Butyro Lactone (Peruvian Lily), 0.01%						
Negative	392 (99.5%)	108 (100%)	0.99	208 (99.5%)	108 (99.1%)	0.99
Positive	2 (0.5%)	0 (0%)		1 (0.5%)	1 (0.9%)	
Sodium Lauryl Sulfate						
Negative	387 (98.2%)	104 (96.3%)	0.26	202 (96.7%)	109 (100%)	0.10
Positive	7 (1.8%)	4 (3.7%)		7 (3.3%)	0 (0%)	
Melamine Formaldehyde, 7% pet						
Negative	390 (99.0%)	106 (98.2%)	0.61	208 (99.5%)	108 (99.1%)	0.99
Positive	4 (1.0%)	2 (1.8%)		1 (0.5%)	1 (0.9%)	
Ethylene Urea, 1%						
Negative	393 (99.8%)	108 (100%)	0.99	208 (99.5%)	109 (100%)	0.99
Positive	1 (0.2%)	0 (0%)		1 (0.5%)	0 (0%)	
Propyl Gallate, 0.5% pet						
Negative	391 (99.2%)	106 (98.2%)	0.29	208 (99.5%)	108 (99.1%)	0.99
Positive	3 (0.8%)	2 (1.8%)		1 (0.5%)	1 (0.9%)	
Octyl Gallate, 0.25% pet						
Negative	390 (99.0%)	108 (100%)	0.58	207 (99.0%)	108 (99.1%)	0.99
Positive	4 (1.0%)	0 (0%)		2 (1.0%)	1 (0.9%)	
Primin, 0.1% pet.						
Negative	393 (99.8%)	107 (99.1%)	0.38	208 (99.5%)	109 (100%)	0.99
Positive	1 (0.2%)	1 (0.9%)		1 (0.5%)	0 (0%)	
Palladium Chloride, 1% pet						
Negative	371 (94.2%)	104 (96.3%)	0.48	198 (94.7%)	103 (94.5%)	0.93
Positive	23 (5.8%)	4 (3.7%)		11 (5.3%)	6 (5.5%)	
Triclosan						
Negative	394 (100%)	108 (100%)	N/A	209 (100%)	109 (100%)	N/A
Positive	0 (0%)	0 (0%)		0 (0%)	0 (0%)	
Disperse Red 17, 1% pet						
Negative	393 (99.8%)	108 (100%)	0.99	208 (99.5%)	109 (100%)	0.99

Positive	1 (0.2%)	0 (0%)		1 (0.5%)	0 (0%)	
Gentamycin						
Negative	387 (98.2%)	107 (99.1%)	0.99	206 (98.6%)	108 (99.1%)	0.99
Positive	7 (1.8%)	1 (0.9%)		3 (1.4%)	1 (0.9%)	
Thimerosal						
Negative	361 (91.6%)	95 (88.0%)	0.24	195 (93.3%)	95 (87.2%)	0.07
Positive	33 (8.4%)	13 (12.0%)		14 (6.7%)	14 (12.8%)	
Tobramycin						
Negative	393 (99.8%)	107 (99.1%)	0.38	208 (99.5%)	109 (100%)	0.99
Positive	1 (0.2%)	1 (0.9%)		1 (0.5%)	0 (0%)	

Chi-square of Fisher exact tests of association comparing current AD and standard/supplemental allergens.

