Risk factors for atopic dermatitis in southern Puerto Rico

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Background: **Little is known about the risk factors and exposures to aeroallergens in subjects with atopic dermatitis (AD) in Southern Puerto Rico. The objective was to determine the prevalence of skin reactions to aeroallergens and to analyze self-reported risk factors in AD patients and a nonallergic control population.**

Methods: **A cross-sectional study was conducted which included 726 AD patients and 313 nonallergic control subjects. Skin tests were conducted and a questionnaire was self-applied to all participants.**

Results: **Seventy six percent of the AD patients showed at least one positive skin reactions to aeroallergens. Of these, half had positive skin reactions to dust mites, and one third to *Periplaneta americana*. A low prevalence of positive skin reactions to dog, cat, plant and fungal allergens was detected. Co-sensitivitity between mites and cockroaches was 30%. The maximum skin reactivity to mites was at 10-19 years of age declining thereafter while skin reactivity to dogs, and plants increased with age. No significant differences in the prevalence of skin reactions was observed between the male and female AD population.**

Conclusions. **Of the aeroallergens tested, those derived from dust mites are the most frequent sensitizing agents in the AD patients. Data also showed that the mites *B. tropicalis* and *E. maynei* are also important sources of sensitization. Our study show that young patients specially those between the age of 10-19 age group are the most allergic. Being female, or having an asthmatic father are significant risk factors associated with allergen sensitivity in the AD population.**

Key words: Risk factors, Atopic dermatitis.

Atopic dermatitis (AD) usually appears in childhood with the majority of patients developing skin lesions before 5 years of age (1). The development of this disease is influenced by numerous risk factors including maternal smoking, viral infections, air pollution, breast feeding, inhaled allergens, genetic susceptibility, age of exposure, gender, race and socioeconomic status, and prenatal exposure (2). Some of the most common risk factors for exacerbation of AD symptoms include exposure to allergens, micro-organism infections, stress, sweating and climate (3).

There is a geographic variation in the prevalence of AD (4). These regional variations in the prevalence may be explained in part, by the differences in the nature and extent of the environmental exposures (5-7). Regardless of the type of allergen, environmental exposures play a role in the disease expression. Little information is available on risk factors for AD in Puerto Rico, and therefore, it is of vital importance to identify the sensitization rates and common risk factors in AD for better patient management is to be achieved.

The objective of the present study was to investigate the reactivity to aeroallergens and to identify important self-reported risk factors associated with atopic dermatitis in subjects living in a tropical environment.

Materials and Methods

Study design and subjects. A cross sectional study was conducted, and the study population was comprised of 793 consecutive subjects with a primary diagnosis of AD by a dermatologist (JV), and 313 control subjects without self-reported allergies. After the medical diagnosis was established, the patients were referred to our laboratory for the study. The controls were randomly recruited from local health fairs, routine follow-up visits to health clinics and community hospitals for other reasons than atopic dermatitis, and from patient companions during

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their visits. Each subject was unrelated and represented different households. The sample size obtained allowed to explore odds ratios of 1.9 or larger for skin positive reactions found in 10% or more individuals of the study sample (8).

The inclusion criteria were: 1) dermatologist-based clinical diagnosis and active symptoms of atopic dermatitis at the time of visit, 2) valid skin test, subject responded to the histamine positive control with a wheal greater than 3 mm^2 and without a wheal greater than 3 mm to the negative control or to dust mite culture medium; 3) completion of a self-applied questionnaire composed of close-ended items on demographics, family history of allergy and self-reported environmental exposures; and 4) not taking medications, such as antihistamines and tricyclic anti-depressives that could interfere with the skin prick tests (SPT). Prior to testing, all of the participants read and signed the Institutional Review Board approved informed consent forms.

A total of 79 (7.0%) subjects were excluded. Of these, 66 (8.4%) were AD patients while 12 were controls (3.7%). There were significant differences in the age between those who were excluded from the study and those who were not (respectively, 37.3 " 20.3 yrs vs 23.9 " 19.3 yrs, P=.0001).

Dust mite allergen extracts for skin testing. Extracts from the mites *Blomia tropicalis* (BT) and *Euroglyphus maynei* (EM) are not commercially available and were prepared as previously reported (9). Mite cultures of *B. tropicalis* were produced in our laboratory while *E. maynei* were kindly provided by Dr. B. Hart. As an additional control, an extract from mite culture medium was also prepared as described.

*Skin prick testing***.** Skin-prick tests were performed in the volar surface of both arms in intact, nonsteroid-treated skin according to Pepys (10). The skin reaction was recorded at 15 min. A skin reaction was considered positive was if it had a wheal equal to or greater than 3 mm^2 in the mean diameters (11-12). Positive (histamine 1 mg/ml) and negative (sterile PBS in 50% glycerol) controls, and an extract of the mite culture growth medium were included in the skin testing. For the prick tests, sterile disposable acrylic copolymer needles were used (Morrow Brown, Oakhurst, NJ). The glycerinated extracts were purchased from a single vendor (Hollister Stier, Spokane, WA). The following allergen extracts were tested in the study population: *Dermatophagoides pteronyssinus* (DP), *D. farinae* (DF), *Blomia tropicalis* and *Euroglyphus maynei*, *A*merican cockroach *Periplaneta* (PA) *americana*, cat (CT) and dog dander (DG). We used allergen mixes to pollen from weeds (PW), trees (PT) and grasses (PG) and molds (Mix A and B). These allergen mixes have been used in previous studies conducted in Puerto Rico (9,13). All of the participants were tested using the same allergen lot and preparations.

Data analysis. Sample size determination and data analysis was conducted using a commercial statistical software (Stata, Stata Corporation, College Station, TX). The participants were divided into two groups: AD and nonallergic controls, and subdivided by age, and to sensitization to animal, plant or fungal allergens. Seven age groups were used (Table 1). Positive skin reactions to animal allergens were classified for house dust mites, pets (dogs and cats) and cockroaches, while to plant allergens were considered pollen from grasses, trees and weeds. Positive skin reactions to fungal allergens were considered those skin reactions positive to mold mixes. The atopic index (AI) was defined as the total number of positive skin tests out of 12 allergens. The mean wheal diameter (MWD) was also calculated for all of the participants on the skin reactions. Continuous variables were expressed as the mean "standard deviation (untransformed). We compared the cases and controls and age groups using an analysis of variance (ANOVA) with a Scheffe's test to determine differences within groups. Graphical representation of data included mean values" SD. Pearsons's correlation coefficients, their determination coefficient percent and 95% CI for the correlation coefficients were used to analyze associations between the allergic index and wheal diameters, and between allergens. Multiple linear regression using the beta coefficients was conducted to assess the relative strength of each of the predictors. The comparison of skin reactivity between cases and controls to different allergens was carried out by using 2 x 2 tables, the odds ratios (OR) were used as a measure of rate difference, Cornfield's 95% confidence intervals for the odds ratio (14-15). Age and sex adjusted OR were calculated by using the Mantel-Haenzel stratified analysis (16). Test for OR trend between age and skin reactions to allergens were analyzed using the chi square test for linearity according to Fleiss (17). By convention, the level of significance was established at $p<0.05\%$.

Results

Study population. A total of 1039 participants, 726 (70.0%) had a confirmed diagnosis of atopic dermatitis while 313 (30.0%) were nonallergic controls (Table I). In the AD group the mean age was 19.72 "18.35 years, and for the nonallergic subjects was 33.9 "17.7 years. There were significant differences between the cases and controls (mean difference 14.8 yrs, P=0.0001). In the AD subjects, 51% (n=370) were females while 49% (n=356) were males. In the nonallergic control group, 84.0% (n=263)

Table 1. Age and gender distribution of the study population

	Atopic Dermatitis (n=730)				Controls (n=313)				Total	
	Females		Males		Females		Males			
Age-group	**n**	**%**	**n**	**(%)**	**n**	**(%)**	**n**	**(%)**	**n**	**%**
0-9	115	30.7	215	60.4	18	6.8	17	34.0	365	35.0
10-19	73	19.5	71	19.9	32	12.2	6	12.0	182	17.4
20-29	41	10.9	17	4.8	52	19.8	7	14.0	117	11.2
30-39	52	13.9	16	4.5	58	22.0	3	6.0	129	12.4
40-49	49	13.1	18	5.1	55	20.9	10	20.0	132	12.7
50-59	24	6.4	10	2.8	21	8.0	5	10.0	60	5.8
60+	20	5.3	9	2.5	27	10.3	2	4.0	58	5.6
Total	**374**	**100**	**356**	**100**	**263**	**100**	**50**	**100**	**1043**	**100**

were females and 16% (n=50) were males. In general, 61% (n=633) were women and 39.0% (n=406) were men. In the AD group, significative differences in age were observed between female and male subjects (respectively 24.9”19.2 and 14.2"15.6, P=0.0001), as well as in the nonallergic group (respectively 35.3"16.9 and 25.7"19.8, P=0.0000).

Prevalence and degree of sensitization to allergen groups. Seventy six percent of the AD patients had a positive skin reaction to at least one allergen, while in the nonallergic controls (46.6%) had at least one positive skin reaction. In the AD subjects, skin reactivity to animal allergens showed the highest frequency of all allergens tested, and within this category, skin reactions to dust mites had the highest frequency of positive skin reactions. The prevalence of skin reactions is detailed in Table 2. Comparison of the skin reactivity between the AD and

Table 2. Comparison of positive skin reaction by allergen between atopic dermatitis patients and a control population in Puerto Rico

Positive skin reactivity to	**Dermatitis (n=726)**	**Controls (n=313)**	**crude OR**	**adjusted OR (95%CI)***	**P**
Skin reaction to at least one allergen	76.2% (n=553)	46.7 (n=146)	3.68	3.94 (2.88-5.39)	>0.0001
Animal allergens	71.7% (n=521)	43.4 (n=136)	3.37	3.39 (2.50-4.59)	>0.0001
Dermatophagoides pteronyssinus	58.1% (n=422)	28.5% (n=89)	3.50	2.99 (2.20-4.06)	>0.0001
D. farinae	55.1% (n=403)	26.2% (n=82)	3.51	3.13 (2.29-4.28)	>0.0001
Blomia tropicalis	52.1% (n=378)	23.4% (n=75)	3.46	2.92 (2.13-4.01)	>0.0001
Euroglyphus maynei	50.1% (n=364)	17.6% (n=55)	4.74	3.66 (2.60-5.16)	>0.0001
Dog dander	9.2% (n=67)	5.1% (n=16)	3.90	3.67 (2.41-5.57)	>0.0001
Cat hair	17.6% (n=128)	9.6% (n=30)	1.96	2.89 (1.60-5.22)	>0.0001
Periplaneta americana	31.4% (n=228)	10.5% (n=33)	2.04	3.08 (1.94-4.87)	>0.0001
Fungal	14.4% (n=105)	6.4% (n=20)	3.55	3.54 (2.09-6.00)	>0.0001
Mold Mix A	9.5% (n=69)	4.1% (n=13)	3.46	3.51 (1.84-6.69)	>0.0001
Mold Mix B	7.7% (n=56)	5.1% (n=16)	2.01	1.98 (1.08-3.63)	>0.0001
Plant	22.2% (n=161)	11.8% (n=37)	3.80	3.13 (2.07-4.74)	>0.0001
Pollen from trees	9.5% (n=69)	6.4% (n=20)	2.28	2.26 (1.31-3.91)	>0.0001
Pollen from weeds	8.1% (n=59)	6.4% (n=20)	1.99	1.94 (1.10-3.41)	>0.0001
Pollen from grasses	12.8% (n=93)	6.7% (n=21)	2.99	3.00 (1.77-5.07)	>0.0001

*Adjusted by age and gender

nonallergic group demonstrated that AD patients had 3.39, 3.54 and 3.13 times more skin reactions than the controls to animal, fungal and plant allergens respectively. Figure 1 details the skin prevalence to allergens in the different age groups. The majority of AD patients were sensitized to animal allergens, and the highest prevalence of positive skin reactions was observed in the 10-19 age group. Lower skin reactivity was detected to fungal and plant (Figure 1) allergens. In the AD population, we found

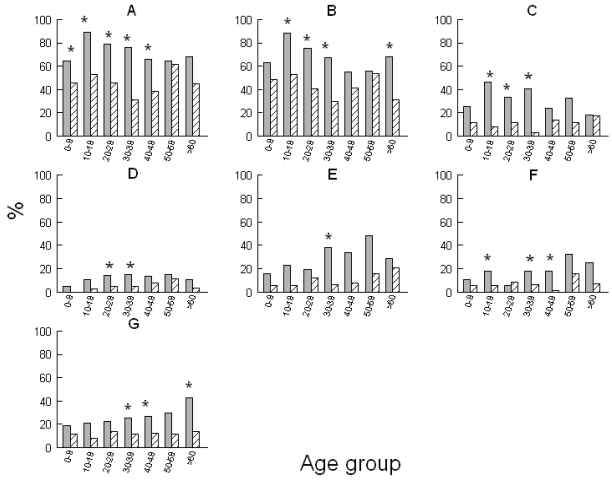

Figure 1. Frequency of skin reactivity of AD patients (Solid Bars) and non allergic controls (Cross-hatched Bars) by age. A: Animal allergens, B: Mites, C: American cockroach, D: Cat, E: Dog, E: Fungal and H: Plant allergens. Asterix denotes significant differences in the frequencies between AD and Non-allergic controls.

8.6% of the AD patients had positive skin reactions to one mite species, 7.8% to two mite species, 10.7% to three and 39.9% to all of the mites tested. Co-sensitivity between mite and cockroach allergens was 16.1% (data not shown). In the AD population, exclusive skin reactions to animal allergens was 47.2% (n=343), to plant allergens was 1.8% (n=13), and to fungal allergens was 0.7% (n=5).

Mean wheal diameter and mean atopic index according to age, diagnosis and gender. The frequency of the allergic index in the AD cases and nonallergic controls was analyzed. Details are summarized in Figure 2. The specific MWD was also analyzed according to age and the results are illustrated in Figure 3.

Significant correlations (P<0.05) between the reactivity to the four mite species and other animal allergens were detected (Table 3) Also, we observed a positive relationship between mean wheal diameter and allergic index (r^2=0.86). Each of the allergenic extracts were analyzed individually for their correlation to the mean wheal diameter and the allergic index. The following

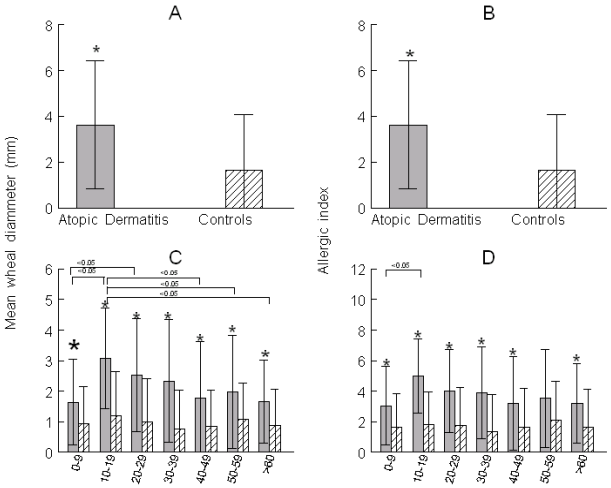

Figure 2. Comparison of the mean wheal diameter (MWD) and Mean allergic index (MAI) Between atopic dermatitis and controls. inserts A and B show significative differences in the mean wheal diameter and allergic index between AD patients and controls. Insert C in all age groups compared. Within cases, the 10-19 years age group had the highest mean wheal diameter. Insert B represents. The MAI. Significative differences were obtained between cases and controls in all age groups compared except in the 50-59 years. Within cases, it can be observed that the 10-19 years age group had the highest mean allergic index.

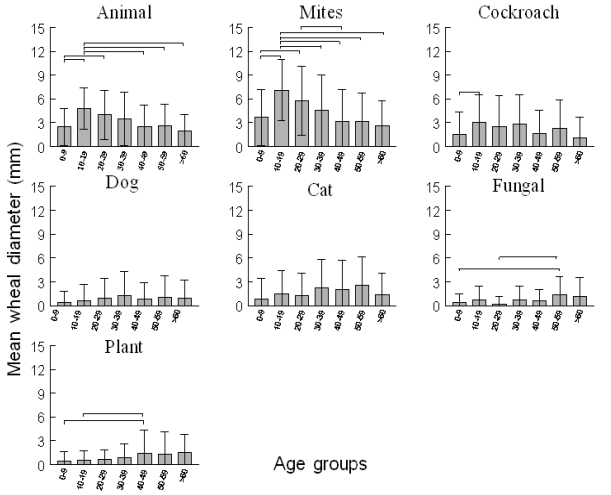

Figure 3. Comparison of the allergen specific mean wheal diameter in ad cases according to age. Significative differences were detected in animal allergens, mites and cockroaches. The horizontal lines indicate significance at <0.05 level.

significant results were obtained from the mean wheal diameter: DP (r^2=0.72), DF (r^2=0.71), EM (r^2=0.66), BT (r^2=0.62). For the atopic index, the following significant results were obtained: DP (r^2=0.58), DF (r^2=0.56), EM (r^2=0.54), BT (r^2=0.49). Multivariate regression analysis showed that DP was the most important predictor for the

Table 3. Correlationships between allergens in atopic dermatitis patients

Allergen	DP	DF	EM	BT	PA	CT	DG	PT	PW	PG	MA
DP	1										
	2										
	3										
DF	87.2%										
	0.76										
	0.765-0.766										
EM	85.4%	53.3%									
	0.73	0.73									
	0.730-0.730	0.730-0.730									
BT	44.9%	44.9%	36.0%								
	0.67	0.67	0.6								
	0.674-0.675	0.678-0.679	0.664-0.665								
PA	16.0%	16.0%	14.4%	14.4%							
	0.40	0.40	0.3	0.3							
	0.400-0.401	0.408-0.409	0.386-0.387	0.385-0.386							
CT	4.4%	2.6%	2.9%	2.2%	4.4%						
	0.21	0.16	0.17	0.1	0.21						
	0.217-0.218	0.167-0.168	0.174-0.174	0.151-0.152	0.212-0.213						
DG	1.9%	1.4%	1.7%	2.1%	2.2%	3.9%					
	0.14	0.12	0.13	0.14	0.15	0.19					
	0.145-0.146	0.129-0.130	0.133-0.133	0.145-0.146	0.513-0.154	0.197-0.198					
PT	0.7%	0.5%	9.0%	0.6%	0.1%	1.9%	8.2%				
	0.085	0.07	0.3	0.08	0.04	0.13	0.28				
	0.085-0.086	0.074-0.074	0.031-0.032	0.082-0.083	0.040-0.040	0.139-0.140	0.028-0.028				
PW	2.2%	0.5%	0.2%	1.2%	0.4%	2.5%	2,2%	13.6%			
	0.15	0.06	0.05	0.1	0.06	0.15	0.14	0.36			
	0.150-0.150	0.066-0.067	0.054-0.055	0.111-0.112	0.065-0.066	0.157-0.158	0.148-0.148	0.369-0.369			
PG	0.4%	0.2%	0.03%	0.4%	0.09%	8.0%	0.6%	7.3%	11.7%		
	0.06	0.046	0.019	0.06	0.03	0.28	0.07	0.27	0.34*		
	0.062-0.063	0.046-0.047	0.018-0.019	0.061-0.062	0.030-0.031	0.283-0.284	0.077-0.078	0.270-0.271	0.340-0.341		
MA	0.2%	0.09%	0.04%	0.2%	1.0%	0.6%	0.9%	5.2%	4.0%	1.5%	
	0.05	0.03	-0.02	0.04	0.1	0.08	0.09	0.22	0.20	0.12	
	0.052-0.053	0.038-0.039	-0.02-0.01	0.045-0.045	0.100-0.100	0.080-0.081	0.095-0.096	0.228-0.229	0.206-0.207	0.123-0.124	
MB	0.04%	0.16	0.04%	0.02%	0.02%	0.4%	3.2%	3.7%	0.8%	3.2%	5.4%
	0.02	0.04	0.02	0.01	-0.01	0.06	0.18	0.19	0.09	0.18	0.23
	0.022-0.023	0.047-0.048	0.025-0.026	0.016-0.017	4-0.015-0.014	0.060-0.061	0.189-0.180	0.193-0.194	0.097-0.098	0.181-0.182	0.233-0.234

DP: *Dermatophagoides pteronyssinus*, DF: *D. farinae*, BT: *Blomia tropicalis*, EM: *Euroglyphus maynei*, PA: *Periplaneta americana*, CT: cat dander, DG: dog dander, PW: pollen from weeds, PT: pollen from trees, PG: pollen from grasses, MA: mold mix A and MB: mold mix B.
1. Determination coefficient percent: (r^2)100
2. Correlation coefficient: r
3. 95 percent confidence intervals fo the correlation coefficient: 95% CI r

mean wheal diameter, followed by DF, BT and EM (Table 4). For the atopic index, the dust mites BT, EM, and DF, and PA the most important predictors of polisensitization.

Relationship between gender, age and skin reactivity to allergens . We investigated the trend of the odds of positive skin reactions to allergens and age in the AD cases. Significant trends were detected in DP, EM, BT , CT and fungal allergens. A linear trend between the OR of having a positive skin reaction and age, was only observed in dog and plant allergens (Figure 4).

Presence of self-reported risk factors. AD subjects were 3.93 times more likely to be atopic than the nonallergic controls, and 2.85 times and 1.93 more likely to have and asthmatic mother and father than the controls. We also found that volunteers between the ages of 0-9 years old were 4.59 times more likely to have AD than the controls. Females were 0.46 times likely to have atopic dermatitis. Subjects who reported using either mattress or pillow encasings were 0.73 times less likely to develop AD symptoms but this failed to be significant.

Self-reported prognostic factors for atopy. Atopic AD patients were 1.66 times more likely to have an asthmatic father and 1.98 times more being females than males. Females were more likely than men to have positive skin reactions with the exception of cockroaches (Table 5).

Discussion

In the present study, dust mites were the most frequent sensitizing agents for subjects with AD, and cockroach the second. In fact, mites were very important contributors for allergic sensitization in our population as evidenced by the rank order among the aeroallergens tested. Plant and fungal allergens had lower skin reactivities followed by cat and dog dander. Older children and adolescent patients had higher risk of being sensitized to dust mites,

Table 4. Multivariate linear regression for the measurement of the relative strength of wheal predictors by rank

Rank/ Predictors (allergens)	Beta Coefficients
1. DP	.2344874
2. DF	.2332809
3. BT	.2251847
4. EM	.2019525
5. PA	.1579956
6. CT	.1441597
7. DG	.09699
8. MA	.0969743
9. PT	.0923391
10. PW	.0910864
11. MB	.0849162
12. PG	-.0092446

*Standardized coefficients, DP: *Dermatophagoides pteronyssinus*, DF: *D. farinae*, BT: *Blomia tropicalis*, EM: *Euroglyphus maynei*, PA: *Periplaneta americana*, CT: cat dander, DG: dog dander, PW: pollen from weeds, PT: pollen from trees, PG: pollen from grasses, MA: mold mix A and MB: mold mix B.

whereas older patients to plant and dog allergens. AD patients were more likely to have an asthmatic mother or father than the control group.

Data from different parts of the world show, whether in cold or tropical climates, show that dust mite allergens

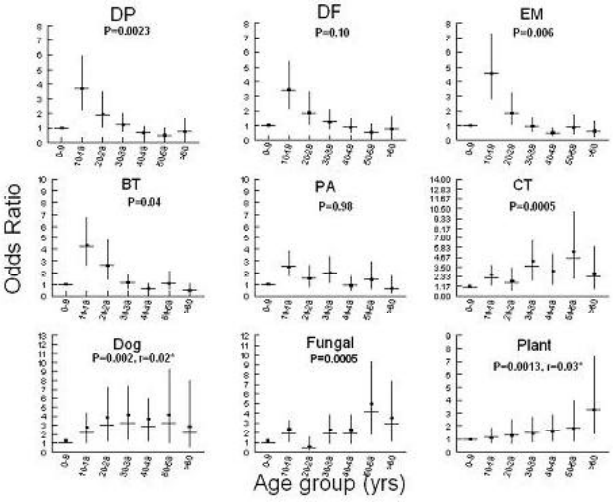

Figure 4. Significative score tests for linear trend of positive skin reactivity to allergens in subjects with AD by age. DP: Dermatophagoides pteronyssinus, DF: D. Farinae, EM: Euroglyphus maynei, BT: Blomia tropicalis, PA: American cockroach. The solid square represents the odds ratio, and the vertical line the 95% confidence intervals. The asterix denotes the presence of linearity in the OR.

specially from *D. pteronyssinus* and *D farinae*, are the most common sensitizing allergen sources for AD patients (18-22). The reported prevalence of positive skin reactions to dust mites range from 60% to 100%. Our results are line with these published reports. We also analyzed the skin sensitivities to two additional dust mite species, *B. tropicalis* and *E. maynei* which are found in Puerto Rico (23). These species are also found in many parts of the world, and have been associated with clinical manifestations of atopy (24-32).

Our data show that allergens produced by *B. tropicalis* and *E. maynei* are also important risk factors for AD as *D. pteronyssinus* and *D. farinae* and reflect environmental exposures to mite allergens found in Puerto Rico (31).

Cockroach sensitivity has been reported as one the most important risk factors for the development of allergy (33-36). The prevalence of cockroach sensitization in US urban centers varies from 53-69% (37). In our study, the AD patients had a skin prevalence of 30% and were 3.67 times more frequently reactive to cockroach than the nonallergic controls ($p<0.0001$). Our low sensitization prevalence can be explained by the environmental conditions and housing characteristics in Puerto Rico which are different than those reported in urban centers and AD patients. Typically, our housing conditions include highly ventilated one story houses or small apartment buildings. Possibly, our patients are exposed to lower allergen levels than those reported in large urban apartment complexes (38-39).

In our study, the prevalence of skin reactions to dust mites showed an increased reactivity in the younger patients with the highest peak at the age 10-19 years, followed by a decreasing trend thereafter. Several studies have reported similar reactivity patterns but with different peaks of maximum reactivity. Barbee *et al* reported the increase of SPT reactivity in the first years of life rising to a peak in the third decade, with a decrease after 50 years (40).

Barbee RA, Brown WG, Kaltenborn W, Halonen M. Allergen skin-test reactivity in a community population sample: correlation with age, histamine skin reactions and total serum immunoglobulin E. J Allergy Clin Immunol 1981;68:15-9 while others have reported the maximum reactivity peaks at 10 years, (41) and 20-34 years (42). Our finding is within the reported ranges, and indicates later sensitization to airborne allergens in the AD population (43-44). The decline in the skin reactivity as AD patients grow older could be explained by either as a result of naturally induced tolerance, a real decline in the immune system or a decrease in the ability of the skin to react to immunologic stimuli (45). In contrast to mites, dog, fungal and plant allergens showed a slight increased prevalence in older AD patients. These aging changes in skin reactivity

Table 5. Gender as a prognostic factor for positive skin reactions in subjects with atopic dermatitis, Ponce, Puerto Rico

Allergens	Positive skin reactions	Negative skin reactions	Crude OR (95% CI)	Adjusted OR (95% CI)*	p-value
At least one allergen					
Female	301	69	1.89 (1.25-2.59)	1.98 (1.33-2.95)	0.001
Male	252	104			
Animal					
Female	280	90	1.48 (1.05-2.08)	1.64 (1.13-2.38)	0.0001
Male	241	115			
Dust mites					
Female	265	233	1.33 (.96-1.84)	1.48 (1.04-2.12)	0.019
Male	233	123			
Cockroach					
Female	112	258	0.89 (0.64-1.24)	0.84 (0.59-1.20)	0.36
Male	116	240			
Cat					
Female	88	282	2.46 (1.61-3.80)	2.43 (1.54-3.84)	0.000
Male	40	316			
Dog					
Female	56	314	5.59 (2.82-12.03)	5.46 (2.64-11.30)	0.000
Male	11	345			
Fungal					
Female	82	288	4.12 (2.48-7.03)	3.89 (2.27-6.65)	0.000
Male	23	333			
Plant					
Female	123	247	4.16 (2.75-6.38)	4.12 (2.66-6.37)	0.000
Male	38	318			

*Adjusted for environmental asthmatic mother, asthmatic father, allergic mother, allergic father, and age as a continuous variable.

do not necessarily reflect milder or increased overall allergic activity. It has been shown that in a follow-up study of patients with allergic disease, there was no connection between change in symptom severity and decrease in skin test reactivity (46).

Most of the AD patients had multiple skin reactions that can explained by environmental factors that favor the development of allergens for which survival conditions are similar. Proliferation of dust mites and cockroaches depend on the relative humidity of ambient air. In fact, it has been documented that numerous patients exhibit sensitization to both allergens (47). In this regards, we observed a 30% in co-sensitivity and a positive correlation between cockroaches and dust mites. These observations may be explained in part by the cross reactivity between cockroach allergens with other insects, mites and crustacea (48-49). The cross-allergenicity is of utmost importance because sensitization rates to dust mites or to cockroach allergens may be overestimated, and the true rates may be actually lower. The cross-reactivity between CR and dust mite allergens remains controversial and it's possible that in low percentages of co-sensitivity, CR reactions are specific (50). Of interest was the finding of 46% of the non-allergic controls had positive test responses to 1 or more allergens. On average, an non-allergic individual with a positive test response reacted to 1 to 3 allergens, and most with positive test responses were to dust mites. This prevalence may seem high, however, it is similar to the one obtained in the Third National Health and Nutrition Examination Survey (51).

We analyzed the self reported risk factors for atopy in AD patients, and our findings are consistent with other studies showing that age (10-19 years), gender (females) and family history of asthma (asthmatic mother) are

associated with allergen sensitivity (52). Of the risk factors analyzed, encasings of mattresses and pillows and were found to be of some protection in our study. The use of pillow and mattress encasings for the reduction of inhaled allergens is well documented (53). Therefore, since this a modifiable risk factor, special efforts should me made by physicians to emphasize the benefits of environmental interventions, specially the use of mattress and pillow encasings. We also analyzed prognostic factors for atopy and in our study population, females were more likely to be sensitized to all of the aeroallergens tested with the exception of cockroaches.

Limitations of this study are those associated with the cross-sectional design. The findings are limited to those patients with symptoms associated with atopic dermatitis. It may be possible that mild or milder cases of atopic dermatitis may not seek medical attention and may be under-represented. However, we do not expect to have an important underrepresentation of moderate to more severe cases. The sampling procedure is also a limitation of the study that may generate problems in the social economic strata representativeness of the source population which it has been reported as being positively associated with skin reactions (54). Controls were selected from potentially different sources, and as a result, the AD-control comparison may include a degree of age selection bias. When comparing cases with controls, age and gender adjusted odds ratios were calculated to minimize for further age and gender differences. In population studies, due to the different sources of standardized allergen extracts, it is difficult to make comparisons with other studies. However, for allergens with a world-wide distribution such as mites and cockroaches, our results can be used for comparison purposes. Finally, our study was limited only to aeroallergen reactivity and a food panel was not included. This may limit the prevalence of positive skin test reactions in the AD population.

We have provided strong evidence that for AD patients in Puerto Rico, dust mites are the most important sensitizing agents, and the most sensitive group is composed of older children and adolescents. Our data show that mites *B. tropicalis* and *E. maynei* are important sources of allergens. Strategies to reduce the exposure of children to these allergens should start in early infancy and should be part of AD management. Skin testing should also be performed at early age so that better preventive measures can be implemented. Our data also reinforce the importance of regional climate in influencing aeroallergen sensitivity. Further studies with a larger sample size are strongly recommended in the non-allergic population to determine the degree of sensitization to allergens.

Resumen

En Puerto Rico existe muy poca información sobre los factores de riesgo de Dermatitis Atópica (DA). El objetivo de este estudio fué determinar la prevalencia de reacciones cutáneas a alergénos, y analizar factores de riesgo auto reportados en pacientes con DA, y en un grupo control no alérgico. Este fué un estudio transversal que incluyó un total de 726 pacientes con DA y 313 controles no alérgicos. Se realizaron las pruebas cutáneas, y los participantes respondieron a un cuestionario. El setenta y seis porciento de los pacientes con DA tuvieron al menos una reacción positiva a aeroalergénos. De estos, la mitad tenían reacciones positivas a ácaros, y un tercio a *Periplaneta americana*. Se observó una baja prevalencia de reacciones cutáneas a alergénos de perro, gato y hongos. Sensitividad combinada entre ácaros y cucarachas fué de 30%. El máximo de la reactividad cutánea a ácaros se observó en el grupo de 10-19 años de edad, bajando progresivamente, mientras que la reactividad a perros y plantas aumentó con la edad. No se observaron diferencias significativas en la prevalencia de las reacciones cutáneas entre mujeres y hombres con DA. Podemos concluir que de los aeroalergénos estudiados, aquellos producidos por los ácaros fueron los mas frecuentes en los pacientes estudiados. Los datos demuestran que los acaros *Blomia tropicalis* y *Euroglyphus maynei* son también fuentes importantes de sensitización. Nuestro estudio demostró que en los pacientes jóvenes, especialmente aquellos entre la edad de 10-19 años, son los mas alérgicos. Ser del género femenino, o tener un padre asmático, son riesgos significativos asociados con sensitividad a alergénos en pacientes con DA.

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