

Short communication

Allergy to cockroaches in patients with asthma and rhinitis in an urban area (Madrid)

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Previous studies have established that cockroach allergens are important sensitizing agents in the induction of rhinitis and asthma principally in urban areas. This study was undertaken to assess skin test reactivity and specific IgE antibody reactivity to extracts of *Periplaneta americana* (*P.a.*), *Blattella germanica* (*B.g.*), *B. orientalis* (*B.o.*), and a fecal extract of *B. germanica* (*FEB.g.*) in a group of patients with rhinitis and asthma living in an urban area in Europe. We examined clinical characteristics and aeroallergen sensitivities of 171 consecutive Madrid urban patients with rhinitis and asthma who met the criteria for the study. A comprehensive clinical evaluation was followed by skin prick test with common allergens and saline extracts of *P.a.*, *B.g.*, *B.o.*, and *FEB.g.* and measurement of serum specific IgE antibody to cockroach extracts. The age of patients ranged from 7 to 68 years (mean 20.4 ± 16). A total of 153 (90.5%) subjects were atopic and 19 (10%) were considered nonallergic. Pollen sensitivity (66.5%) was most prevalent, distantly followed by sensitivity to cockroach (25.7%), mite (20%), cat (15.5%), *Alternaria alternata* (14.5%), dog (14%), and food (2%). Skin test reactivity to cockroach extracts was 37 (21.6%) to *B.o.*, 20 (11.6%) to *P.a.*, 19 (11.1%) to *B.g.* and five (2.9%) to *FEB.g.* Twenty-one of these patients had rhinitis, 19 rhinitis and asthma, and one only asthma; 26 had perennial symptoms, while 16 had seasonal (spring) symptoms; three (1.7%) patients had only positive prick test to cockroach; all had perennial rhinitis and/or asthma. Eighteen (10.5%) patients had specific serum IgE (RAST 1 or 2) to *B.o.*, 13 (7.6%) to *P.a.*, and six (3.5%) to *B.g.* Eighty (46.7%) patients had visual evidence of cockroach infestation in their home, mostly *B.o.*; 31 had positive prick test to cockroach ($P < 0.0003$). The results indicate that sensitivity to outdoor allergens (pollen) is more prevalent than to indoor allergens. Cockroach sensitization is the most important indoor allergen in our area, and *B.o.* accounts for most cockroach sensitization.

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Previous studies have established that cockroach allergens are important sensitizing agents in the induction of rhinitis and asthma (1–8). The two most common cockroach species in Spain are *Blattella orientalis* (*B.o.*) and *B. germanica* (*B.g.*); to our knowledge, *Periplaneta americana* (*P.a.*) is not found in Spain. Over the last years, a number of studies have demonstrated that up to 58% of atopic asthmatic patients in the USA are sensitized to cockroach allergens, particularly patients living

in large urban areas (2, 3, 6). However, in Europe, this prevalence seems to be lower; for example, in a Swiss population with rhinitis and asthma, only 6.3% of the patients were sensitized (9) and only 24.5% in a population in Marseille, France (10). Previous studies in Spain have shown a prevalence of positive skin tests to cockroach ranging from 15% (11) to 29% (12) of asthmatic patients, but this is the first study to include four different cockroach extracts.

This study was undertaken to assess skin test reactivity and specific IgE to extracts of *P.a.*, *B.g.*, and *B.o.* and to a fecal extract of cockroach (FEB.g.) in a group of patients with rhinitis and asthma living in an urban area.

Material and methods

To be included in the study, patients had to live in Madrid or in its surroundings. They were consecutively selected from outpatient clinics in a pediatric hospital (Hospital Niño Jesus) and a general hospital (Fundación Jimenez Diaz).

All study subjects completed a questionnaire including: age, sex, atopic background, duration of rhinitis and asthma, presence of symptoms characteristic of rhinitis and asthma, seasonality of symptoms, current symptoms, type of housing and year of construction, visual evidence of cockroach infestation, and type of cockroach (black = *B.o.*; brown = *B.g.*). All patients conformed to the American Thoracic Society definition of bronchial asthma.

Cockroach extracts

Whole bodies of both sexes of *P. americana*, *B. germanica*, and *B. orientalis* were obtained from the Carolina Biological Supply Company, Burlington, NC, USA. The cockroaches were kept at room temperature for 5 days and then killed by freezing at -20°C overnight. Feces were removed from the cages with forceps by a trained technician. Cockroach whole-body extracts and fecal pellets were prepared by homogenizing cockroaches in saline with a Waring blender. The homogenate was mixed overnight at 4°C and centrifuged (18 000 g), and the supernatant was concentrated (Amicon YM2-MWCO, 1 kDa, Amicon Corp., Danvers, MA, USA). The concentrate was centrifuged (105 000 g), dialyzed (MWCO, 3.5 kDa) against saline, and lyophilized. The crude extracts were sterile filtered by a 0.45- μm Millipore® filter (Bedford, MA, USA), cultured on trypticase soybean agar for microorganisms, and toxicity tested by intraperitoneal inoculation of test material into mice before human testing (13). Glycerol was added in equal volume with saline to allergen preparations for skin testing. Extracts were stored at 4°C . Final concentrations of extracts were 10, and 5 mg/ml for FEB.g.

Other extracts

Standardized extracts of *Dermatophagoides pteronyssinus*, *D. farinae*, cat, dog, *Alternaria alternata*, *Olea europaea*, and grass and weed pollens were

provided by the Abéllo-ALK group, Madrid, Spain, and house dust by Bayer, Madrid, Spain.

Skin tests (ST)

Skin prick tests were performed with ALK lancets. A mean wheal diameter of 3 mm, or greater than control solution, was considered positive. Histamine HCL at 10 mg/ml was used as positive control, and glycerosaline solution as negative control.

RAST

Paper disks were activated with CNBr and coated with cockroach extracts as indicated by Ceska et al. (14). Sensitized disks were incubated overnight in duplicate with human sera and after washing with ^{125}I -labeled antihuman IgE mAb (15). Sera were scored in classes according to the Pharmacia standard curve (Pharmacia, Uppsala, Sweden).

Statistical analysis

Significance was determined by chi-square analysis, paired and unpaired Student's tests, and McNemar's test for correlated proportions. The ANOVA test was also performed.

Results

Of the 171 consecutive patients with rhinitis and/or asthma who completed the study, 52% were male and 48% female. The age range was 6–68 years (mean 20.4 ± 16). Seventy-five patients were younger than 17. Eighty-nine reported rhinitis and asthma, 72 rhinitis only, and 10 asthma only. Allergen sensitivity was observed in 153 subjects (90%), and 19 (10%) were considered nonallergic.

Fig. 1 shows the overall prevalence of allergy in patients as determined by skin testing: pollen sensitivity in 114 (66.5%) patients was most prevalent, distantly followed by sensitivity to cockroach in 44 (25.7%), house dust in 33 (19.2%), mites in 35 (20.4%), cat in 27 (15.5%), *A. alternata* in 25 (14.5%), dog in 24 (14%), and food in four (1.1%).

Skin test reactivity to cockroach extracts was as follows: 37 (21.6%) to *B.o.*, 20 (11.6%) to *P.a.*, 19 (11.1%) to *B.g.*, and 5 (2.9%) to FEB.g. (Fig. 2). A total of 44 (25%) patients had at least one positive skin test to cockroach extracts (mean age 16 ± 11 years). As Fig. 2 shows, 12 of these 44 showed skin test reactivity only to *B.o.*, two to *B.g.*, and two to *P.a.* Nineteen patients had a mean wheal diameter greater than 5 mm to *B.o.*, nine to *B.g.*, eight to *P.a.*, and two to FEB.g. (Table 1). All patients skin-test positive to FEB.g. were so to *B.g.* Twenty-one patients reported rhinitis, 19 rhinitis and asthma,

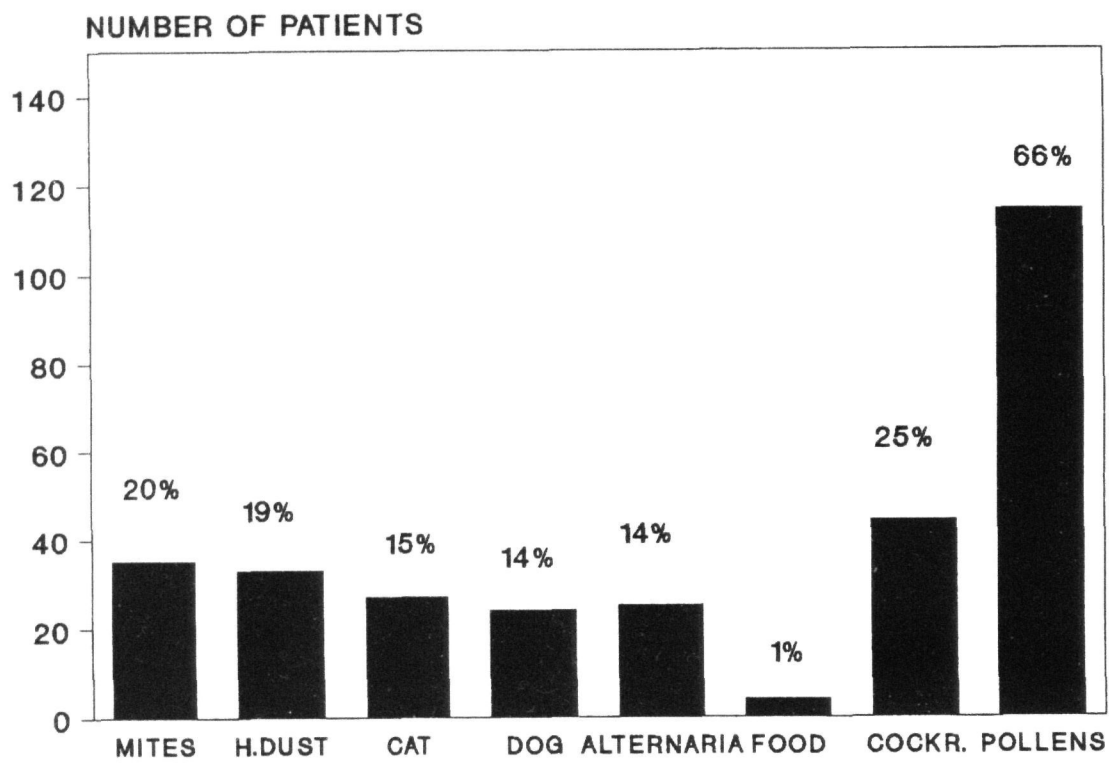


Fig. 1. Frequency of distribution of skin prick tests of subjects studied

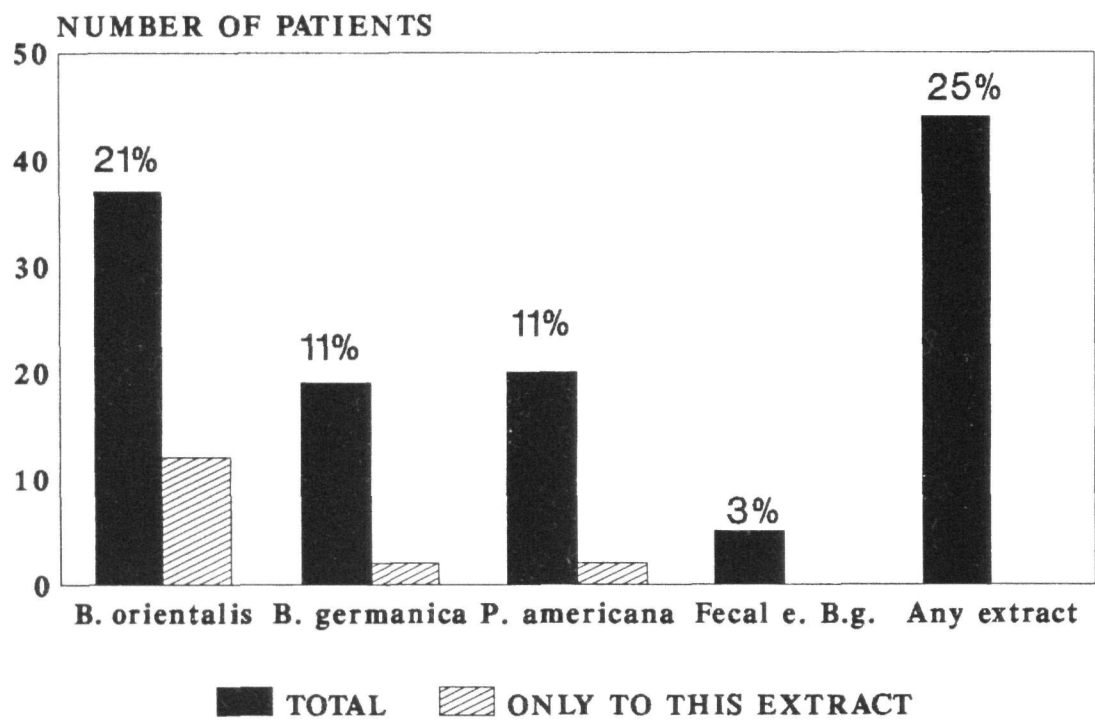


Fig. 2. Results of skin prick tests of study subjects to extracts of *Blattella orientalis*, *B. germanica*, *Periplaneta americana*, and fecal extract of *B. germanica*.

and only one asthma; 26 of them had perennial symptoms and 16 seasonal (spring); three patients had only positive prick test to cockroach, and all had perennial symptoms (two rhinitis and one rhinitis and asthma). In 13 cases, positive skin test to cockroaches was associated with positive ST to house dust (NS); in 12 other cases, to mite (NS); in 11, to animal dander (NS); in six, to *A. alternata* (NS); in 31, to pollen (NS); and in one, to shrimp. Mean age was 16.1 ± 11 years (range 5–50 years) ($P < 0.05$); 28 (63.6%) were male and 16 (36.4%)

female (NS). No patients received cockroach immunotherapy. There was no statistical difference in time of evolution of rhinitis or asthma, or presence of current rhinitis or asthma, or atopic background. The patients with positive skin test to cockroach lived in homes significantly ($P < 0.001$) older – more than 10 years – than those of negative patients.

Twenty-four (14%) patients had at least one positive RAST to cockroach extract. Eighteen (10.5%) patients had specific IgE (RAST class 1

Table 1. Cockroach RAST results

	<i>Blattella orientalis</i>		<i>B. germanica</i>		<i>Periplaneta americana</i>	
	RAST+	RAST-	RAST+	RAST-	RAST+	RAST-
+ST (>3 mm)	15*	21	4*	16	3	17
-ST	3	131	2	148	10	140
+ST (>5 mm)	14*	9	3**	10	3	11
-ST	3	142	3	154	9	147

* $P < 0.0001$; ** $P < 0.01$. ST: skin test.

or 2) to *B.o.*, three of them with negative skin test; 13 (7.6%) to *P.a.*, 10 of them with negative skin test; and six (3.5%) to *B.g.*; and three of the 18 patients had negative skin test. Positive RAST and skin tests were associated for *B.o.* and *B.g.* ($P < 0.0001$), but not for *P.a.* (Table 1).

Eighty (46.7%) patients had visual evidence of cockroach infestation in their home, and 31 of these had positive prick test to cockroach ($P < 0.0003$). Sixty-nine patients had observed black cockroaches (*B.o.*) only, seven black and brown (*B.g.*), and four brown only.

Discussion

The importance of cockroach allergens in induction and/or exacerbation of allergic respiratory diseases has previously been reported (1–8, 12, 16). The most susceptible population is that of the lower socioeconomic class living in the crowded inner city (3, 13).

Our present study confirms the earlier observation in Spain (8, 12) of a relatively high prevalence of skin test reactivity to cockroach among atopic patients with rhinitis and asthma, although the great majority of Madrid residents with rhinitis or asthma are sensitized to outdoor (pollen) allergens. However, cockroach sensitization was the most important indoor allergen in our area. The prevalence of cockroach sensitivity in this study seems to be lower than that reported in the atopic population of some US cities (7), but similar to that reported in other European cities (9, 10, 17, 18).

B.o. accounts for most cockroach sensitization. This may be explained by the fact that most patients who had visual evidence of cockroach infestation in their home reported *B.o.* (black cockroach); in fact, 12 patients were sensitized only to this species. Although this study does not provide direct evidence that cockroaches cause allergic rhinitis or asthma, it is well known from other studies that these insects play a causative role in rhinitis and asthma (1, 4, 5, 11).

In vitro studies have confirmed that the three species studied share common allergens, although specific allergens for each species have also been described (19, 20). This may explain the positive skin test to *P.a.*, a species which does not exist in Spain.

As expected, cockroach RAST results gave a lower positive number than skin tests, demonstrating again that this technique is less sensitive (21) than the skin test. However, as previously reported, the agreement obtained (positive skin test and RAST) is lower (18, 19, 22) than that described for other aeroallergens; i.e., 40.5% for *B.o.*, and only 21% for *B.g.* Nevertheless, for both species, there was a statistically significant association ($P < 0.001$) between positivity in both techniques. If we consider patients with positive RAST and skin test to *B.o.* – the most prevalent cockroach – the prevalence of sensitivity in the population we studied is 8.7%, a prevalence which, in our opinion, justifies the use of this extract in the routine battery of aeroallergens in our area. The skin test results do not indicate that the house-dust extract used effectively identifies cockroach-sensitized patients.

Considering the clinical characteristics of patients with skin reactivity to cockroach extracts, there appear to be a few distinctive characteristics. We found significant association only with visual evidence of cockroach infestation (16), and this affected more patients living in homes built more than 10 years before; slightly younger patients also had a greater tendency to cockroach sensitization. Most patients were sensitized to other aeroallergens, as previously described (3, 6, 8), and it may therefore be prudent to consider, other than in the three patients sensitized only to cockroach, how much these allergens contribute to the allergic inflammation of such patients.

In conclusion, using several cockroach extracts, we confirm a relatively high prevalence (25.7%) of skin test reactivity to cockroach (14% considering positive RAST results only); this is the highest percentage of the indoor allergens tested in atopic patients with rhinitis and asthma. The study further confirms the presence of common allergens among the species tested and the fact that the Oriental cockroach (*B.o.*), the most common cockroach in our geographic area, is responsible for most cockroach sensitization.

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