COCKROACH ALLERGEN IN HOUSE DUST AND SPECIFIC IgE TO COCKROACHES

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Abstract—Cockroach allergen (*Bla g* 1) content was determined in floordust of 46 homes with a recent cockroach extermination in Amsterdam. IgE antibodies to *Blattella germanica* were determined in venous blood samples of 46 children (4–12 years) and one of their biological parents (24–54 years). Specific IgE to cockroach was also determined in sera of children from a case-control study, one group with and three groups without a history of cockroach infestation of the home.

In 44% of the homes cockroach allergen was detected in floor dust. The level ranged up to 3,899 ng *Bla g* I/g. Seven adults (15%) and one child (2%) had a positive RAST to cockroach. Cockroach allergen levels in dust from the living room and master bedroom of sensitized adults were similar to those of non-sensitized adults.

One child (5%) from the homes with a record of cockroach presence, 4 children (16%) from the group with CNSRS, one child (4%) from the group without respiratory symptoms and 11 children (42%) with multiple sensitizations had a positive RAST to cockroach. Only one of the 18 children with a positive RAST to cockroach had a history of cockroach infestation of the home.

INTRODUCTION

The Municipal Pest Control Service of Amsterdam yearly performs cockroach exterminations in roughly one out of every 60 homes. *Blattella germanica* is the dominant species. (1). In a number of small transversal studies published since 1966 the etiological role of cockroach antigen in respiratory disease has been studied. Mostly antibody levels against *Blattella germanica* and *Periplaneta amaricana* were studied in small selected groups of (asthma) patients. In urban atopic populations elevated specific IgE to cockroaches has been reported with prevalences up to 50% (2–6, 8–14, 17, 18, 22, 23). Neither the occurrence of specific IgE to cockroach allergen nor the presence of cockroach allergen in house dust had been studied in Dutch populations.

METHODS

Study population

Inhabitants of homes with recent cockroach extermination.

In 46 houses with a recent cockroach extermination, a biological parent and a child aged 4–12 years were studied. Parents who agreed to participate signed an informed consent. Home visits were made by a trained nurse who administrated a questionnaire about the inhabitants and home characteristics.

Children from a previous case-control study.

In sera of a number of children, aged 6–12 years, who had participated in a previous case control study on respiratory symptoms and home dampness (24), antibodies against *Blattella germanica* were also determined. Information on cockroach infestations in the house during the life of the child was obtained by questionnaire. The selected sera were obtained from: 1) 20 children with a history of cockroaches in the home; 2) 26 children sensitized to two or more allergens, without a history of cockroach infestation; 3) 25 children with chronic non-specific respiratory symptoms (CNSRS), without a history of cockroach infestation and; 4) 25 children without respiratory symptoms and without a history of cockroach infestation.

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Antibody determinations

Venous blood samples were taken by a trained nurse from 46 children and one of their biological parents (24–54 years), usually the mother. After centrifugation, the sera were stored at −20 °C.

IgE antibodies to *Blattella germanica* (whole body extract), house dust mite (*Der p* I, whole *D.pteronyssinus*) were determined using the Pharmacia CAP System (RAST FEIA), Pharmacia Nederland bv, Diagnostics, Woerden, the Netherlands (19). RAST results 10% higher than the transition point from class zero to class one were considered positive (0.385 KU/l).

Specific IgE against cockroach, house dust mite and a number of other allergens were also determined in the 96 children from the case-control study on respiratory symptoms and home dampness.

Dust sampling and assay for cockroach allergens

In the 46 houses, dust samples were taken from the floors of the living room, the master bedroom, and the child's bedroom, by vacuuming an area of 2 m^2 during 4 min in each room. Dust was collected on cellulose filters using a dedicated nozzle marketed by ALK, Horsholm, Denmark. Between each sampling, the sampling nozzle was cleaned with 70% ethanol. The dust samples were extracted by agitation in 0.125M NH_4HCO_3, 0.1% NaN_3 at a ratio of 1:10 (w/v) for two hours at room temperature. The suspension was centrifuged for 15 min at 1,000 g and stored at −20 °C until analysis. Determination of the amount of cockroach allergen was carried out by ALK, Horsholm, Denmark, using an ELISA as described earlier (21). This assay uses antibodies reacting with determinants shared by the allergens of *Periplaneta americana* (*Per a* I) and *Blattella germanica* (*Bla g* I) and does not distinguish between both allergens. In Amsterdam *Periplaneta americana* is rare and was not observed in the houses studied. The results can be expressed in concentration of major allergen per gram of dust and the limit of detection of the method is 1 ng *Per a* I/gram dust or in this case 1 ng *Bla g* I/gram dust.

RESULTS

Cockroach allergens were detected in dust from 20 houses (44%): 12 living rooms (26%), 15 master bedrooms (33%) and 7 child's bedrooms (15%). Table 1 presents the concentrations of cockroach allergens in house dust by type of room and by type of floor covering.

Higher concentrations of cockroach allergens were observed in rooms with textile floor covering. A positive RAST to cockroaches was observed in seven adults (15%) and only one child (2%) of

Table 1. Cockroach allergen in house dust (***ng Bla g I/g***) by room and by type of floor covering.

	n	GM	range	% < detection limit
Living room				
all	46	3.3	<d.l.−1,923	74
smooth	10	–	–	100
smooth+rug	14	3.4	<d.l.−93	71
textile	21	6.0	<d.l.−1,923	62
Bedroom child				
all	46	2.0	<d.l.−316	85
smooth	17	1.3	<d.l.−88	94
smooth+rug	4	8.6	<d.l.−84	50
textile	25	2.5	<d.l.−316	84
Master bedroom				
all	46	5.6	<d.l.−3,899	67
smooth	12	–	–	100
smooth+rug	1	–	–	100
textile	33	11.0	<d.l.−3,899	55

GM: geometric mean; d.l.: detection limit

those living in the 46 homes with a recent cockroach extermination. The geometric mean of cockroach allergen concentrations in the living room and master bedroom of the sensitized adults did not differ with those in the houses of non-sensitized adults. The home of the only child with a positive RAST to cockroach had cockroach allergen in floor dust from the living room (58 ng/g) and from the child's bedroom (95 ng/g).

A positive RAST to house dust mite (*Der p* I) was observed in 12% of the children living in houses with a recent cockroach extermination. The single child in this group with a positive RAST to cockroach had a negative RAST to house dust mite. Five of the seven adults with a positive RAST to cockroach had also a positive RAST to house dust mite.

The results of the IgE determinations in the sera of the children from the case-control study were as follows. One child (5%) of the 20 children from homes with a history of a cockroach infestation during their lifetime, had a positive RAST to cockroach. From the children with and without CNSRS, both groups without a history of cockroach infestation, four (16%) and one (4%) had a positive RAST to cockroach. Among the 26 children with positive RAST to two or more allergens, all without a history of cockroach infestation, 11 (42%) had also a positive RAST to cockroach allergens. Among the 18 children from the case-control study with a positive RAST to cockroach, 16 (89%) also had a positive RAST to house dust mite.

DISCUSSION

We are aware of three studies that reported measurements of cockroach allergens in house dust. Call *et al.* (8) studied the *Bla g* II levels in house dust in the homes of 35 children with asthma and 20 controls in Atlanta. Allergen levels ranged up to approximately 1000 Units/g in the kitchen and the proportion of homes with high levels of cockroach allergen was reported to be similar for both patients and controls. In our study we also found similar levels of cockroach allergen in the homes of adults sensitized and adults not sensitized to cockroach. Sarpong *et al.* (20) measured median *Bla g* II levels of 3.3 to 10.6 Units/g in various sites in 19 bedrooms in a campus dormitory in Baltimore, with the highest level of 388 U/g in a bedroom floor sample. Munir *et al.* (15) reported that in dust from various rooms of 123 houses of asthmatic children in Sweden, cockroach allergens were measured in only one home (40 ng *Per a* I/g dust). In homes with a recent cockroach extermination in Amsterdam clearly higher levels of *Per a* I/*Bla g* I are present in house dust. However higher *Per a* I levels, ranging from 10 to 10000 ng/g, were reported in house dust from the majority of some 70 homes in the Tampa area in south Florida (21).

In the study by Call *et al.* (8) 25% of the children with asthma had specific antibodies to both dust mite and cockroach. In our study three (12%) of the CNSRS cases from the case-control study had a positive RAST to both house dust mite and cockroach. Among the 26 children from the case-control study with two or more positive RAST, almost all CNSRS cases, 48% had a positive RAST to both house dust mite and cockroach. However, for none of the above children a history of cockroach infestation was reported. Recently Witteman *et al.* (25) identified a cross-reactive allergen, presumably tropomyosin, in *Crustacea*, house dust mite and cockroach. In the general population, the prevalence of house dust mite sensitization ranges from 5–30% (16). As, particularly in the lower income city districts, the proportion of cockroach infested houses can be high, cockroach allergens might contribute significantly to the prevalence of CNSRS.

REFERENCES

1. **Annual Reports Pest Control Service Amsterdam (in Dutch), 1991–1994.** Municipal Health Service.
2. **Bernton HS, Brown H. 1976.** Cockroach allergy II: the relation of infestation to sensitization. *Southern Med J* 60: 852–855.
3. **Bernton HS, Brown H. 1969.** Insect allergy: the allergenic potentials of the cockroach. *Southern Med J* 62: 1207–1210.
4. **Bernton HS, Brown H. 1970.** Cockroach allergy: age of onset of skin reactivity. *Ann Allergy* 28: 420–422.
5. **Bernton HS, McMahon TF, Brown H. 1972.** Cockroach asthma. *Brit J Dis Chest* 66: 61–66.
6. **Birnbaum J, Guilloux L, Charpin D, Vervloet D. 1991.** Cockroach allergens. *Lancet* 337: 249.
7. **Call RS, Smith TF, Morris E, Chapman MD, Platts-Mills TAE. 1992.** Risk factors for asthma in inner city children. *J of Pediatrics* 862–866.

8. **Capriles Hulett A, Dockhorn RJ. 1990.** House dust/mite (D. Farinae) and cockroach allergy in a midwestern population. *Ann of Allergy* 42: 160–165.
9. **Guilloux L, Birnbaum J, Lagier-Tessonier F, Charpin D. 1990.** Allergy to cockroaches: in France also. *Am Rev Respir Dis* 141: A249.
10. **Kang B. 1976.** Study on cockroach antigen as a probable causative agent in bronchial asthma. *J Allergy Clin Immunol* 58: 357–365.
11. **Kang B, Vellody D, Homburger H, Yunginger JW. 1979.** Cockroach cause of allergic asthma. Its specificity and immunologic profile. *J Allergy Clin Immuol* 63: 80–86.
12. **Kang B, Chang JL. 1985.** Allergenic impact of inhaled arthropod material. *Clin Rev Allergy* 3: 363–375.
13. **Kang B, Jones J, Johnson J, Kang IJ. 1989.** Analysis of indoor environment and atopic allergy in urban populations with bronchial asthma. *Ann of Allergy* 62: 30–34.
14. **Mendoza J, Snyder RD. 1970.** Cockroach sensitivity in children with bronchial asthma. *Ann Allergy* 28: 159–163.
15. **Munir AKM, Björkstein B, Einarsson R, Schon C, Ekstrand-Tobi A, Warner A, Kjellman N. 1994.** IM, Cat (*Fel d* I), dog (*Can f* I) and cockroach allergens in homes of asthmatic children from three climatic zones in Sweden. *Allergy* 49: 508–516.
16. **Platts-Mills TAE, De Weck AL. 1989.** Dust mite allergens and asthma: a world wide problem. International workshop report. *J Allergy Clin Immunol* 83: 416–427.
17. **Pola J, Valdivieso R, Zapata C, Moneo I, Duce F, Larrad L, Losada E. 1988.** Cockroach hypersensitivity in asthmatic patients. Allergol. *Immunopathol* 16: 105–107.
18. **Pola J, Valdivieso R, Zapata C, Quirce S, Hinojosa M, Losada E. 1988.** Specific bronchial challenge in cockroach asthma. *Allergol Immunopathol* 16: 171–173.
19. **Report Project Cockroach (in Dutch). 1994.** Pharmacia NL Bv Dept of Diagnostics.
20. **Sarpong SB, Wood RA, Eggleston PA. 1994.** Cockroach (CR) allergen (Bla g II): Environmental control with extermination and cleaning. *J Allergy Clin Immunol* 93: A 179.
21. **Schou C, Fernandes-Caldas E, Lockey RF, Lowenstein H. 1991.** Environmental assay for cockroach allergens. *J Allergy Clin Immunol* 88: 847–853.
22. **Schulaner FA. 1970.** Sensitivity to the cockroach in three groups of allergic children. *Pediatrics* 45: 465–466.
23. **Tandon N, Maitra SB, Saha GK, Modak A, Hati AK. 1990.** Role of cockroaches in allergy to house dust in Calcutta, *India. Ann Allergy* 64: 155–157.
24. **Verhoeff AP, van Strien RT, van Wijnen JH, Brunekreef B. 1995.** Damp housing and childhood respiratory symptoms: the role of sensitization to dust mites and molds. *Am J Epidemiol* 141: 103–110.
25. **Witteman AM, Akkerdaas JH, van Leeuwen J, van der Zee JS, Aalberse RC. 1994.** Identification of a cross-reactive allergen (presumably Tropomyosin) in Shrimp, mite and Insects. *Int Arch Allergy Immunol* 105: 56–61.