

Brief communications

The role of mattress bases in the mite infestation of dwellings

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Domestic mites have been found to play a major role in the initiation and development of allergic diseases, mainly asthma and rhinitis.¹ House dust mites and their allergens have been found in mattresses, carpets and rugs, chairs, sofas, and couches and in clothing.^{2,3} The most popular niches in homes are furnishings containing textiles. The role of mattress bases (which are mostly box springs in the United States) in the mite infestation of bedrooms has not yet been studied. There are different types of mattress bases: spring base, slatted base, and upholstered base. In Western countries such as France, the United Kingdom, and the United States, upholstered bases are very common and could contribute to mite infestation in dwellings. The aim of this study was to investigate the role of mattress bases as mite allergen reservoirs and to compare their mite antigen content with those of traditional sources of mite allergens such as mattresses and floors.

METHODS

Selection of bedrooms

We contacted outpatients with mite allergy whose domestic environment had previously been investigated, and investigations included measurement of mite infestation by group 1 allergen determination. All patients had a documented history of asthma or rhinitis and perennial symptoms suggestive of house dust allergy. Results of skin prick tests were positive in response to *Dermatophagoides pteronyssinus*, and all patients had specific IgE for *D. pteronyssinus* ($\geq$ class 3). Fifty-four families from the Strasbourg area who had a group 1 mite allergen content in mattress dust of 2 $\mu\text{g}/\text{gm}$ or greater agreed to participate. No special avoidance procedures had been applied in their homes over the past year. Neither the mattresses nor the bases were encased with dust-proof covers.

Dust sample collection

Three weeks after the last cleaning, dust samples were collected from mattresses, bases, and floors at the same time by

Abbreviation used

mAb: Monoclonal antibody

the same technician, using a standardized method. The time spent vacuuming and the area vacuumed were standardized as follows: 2 minutes per square meter for the three collection sites (mattresses, mattress bases, and floors). Both the mattresses and mattress bases were directly vacuumed. The area vacuumed ranged from 3 to 4 m^2 . For bedroom floors, the area of carpeted surfaces vacuumed was 4 m^2 or greater; for hard floors, a greater area was vacuumed ($\geq 8 \text{ m}^2$). The same vacuum cleaner was used for all samples (1200 W; Philips, Gröningen, The Netherlands). Dust samples were stored in sealed plastic bags at 4° C until they were processed.

Determination of group 1 allergen contents

The dust samples were weighed, sieved, and extracted; and the supernatant was assayed for Der p 1 and Der f 1 by using a two-site monoclonal antibody (mAb) ELISA (mAb 5H8 specific for Der p 1 and mAb 6A8 specific for Der f 1).⁴ The results are expressed in micrograms of major allergens per gram of fine dust. Group 1 allergens were defined as the sum of Der p 1 and Der f 1 per gram of house dust.

Questionnaire

After collection of dust samples, the technician completed a questionnaire about the subject's indoor environment and recorded the following information: age and size of mattresses, type of flooring, private home or apartment, and floor level.

Statistical analysis

First, the normality of the distribution was tested by using the Kolmogorof-Smirnov test. All the quantitative variables had a log-normal distribution, except the age of the mattresses, which was normally distributed. We nevertheless used a nonparametric method (Mann-Whitney U test) to compare the differences of allergen concentrations in the various groups because the distribution tests were not powerful enough. To obtain better information from our samples, we also log-transformed the concentration variables, which enabled us to calculate the Pearson's linear correlation coefficients, the interpretation of which was facilitated by factorial analysis, and to perform multivariate factorial analysis of variance. Multivariate factorial analysis of variance was used because there was a natural correlation between the dust samples collected from the floors, the mattress bases, and the mattresses samples of each dwelling. All the data were processed with either Statgraphics (Uniware) or SPSS version 6 (SPSS) software. The significance level is 5%.

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J Allergy Clin Immunol 1997;99:261-3.

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0091-6749/97 \$5.00 + 0 1/54/77912

TABLE I. Der p 1 + Der f 1 allergens (micrograms per gram) in house dust from mattress, base, and floor samples from 54 dwellings

Location	n	Geometric mean	Median	Statistical deviation	Range
Floors	54	0.8	1.6	6.7	0.05-27.3
Mattresses	54	38.4	19.0	63.1	2.2-335.6
Bases	54	92.6	48.3	151.3	3.7-457.4

RESULTS

In the dwellings of the 54 families who agreed to participate, the three samples collected from mattresses, mattress bases, and floors weighed at least 50 mg and permitted the preparation of extracts for allergen measurement. Twelve of 54 extracts obtained from floor samples had an allergenic content below the assay's sensitivity, which is 0.05 µg/ml for Der p 1 and 0.007 µg/ml for Der f 1. The 12 samples were excluded from statistical analysis.

Distribution and correlations of Der p 1 + Der f 1 in floors, mattress bases, and mattresses

Table I shows the large variations in mite allergen content in each of the three samples collected in the 54 different dwellings. The amount of group 1 mite allergen in house dust samples from carpeted floors was greater than that in house dust samples from hard floors (wooden or linoleum), with geometric means of 2.44 versus 0.15 and medians of 3.63 versus 0.06 ($p < 0.02$). The increasing geometric means of Der p 1 + Der f 1 were significantly different for floors, mattress, and mattress bases (mattress bases vs mattress, $p < 8.10^{-5}$; mattress bases vs floor, $p < 3.10^{-10}$; mattress vs floor, $p < 7.10^{-7}$). These differences remain significant if one considers Der f 1 and Der p 1 separately.

The mite allergen content of bases was higher than that of mattresses in 44 of 54 cases. In two cases the amount of group 1 allergens was equal for both sites, and only in 10 samples was the mattress group 1 allergen content greater than that of mattress bases.

Most samples contained antigens from both *D. pteronyssinus* and *D. farinae*. Only 13 mattress samples had a single species (10 had *D. farinae* and 3 had *D. pteronyssinus*). *D. farinae* was the predominant species in 36 of 54 samples. When a predominant species was found in the mattress, the same species was found in mattress bases and floors. A significant correlation was found between the allergen content of a given species in mattresses and the allergen content of the same species in mattress bases (for Der p 1 $r = 0.69$, $p = 10^{-4}$; for Der f 1 $r = 0.75$, $p = 10^{-4}$). A similar significant correlation was also found when the sum Der p 1 + Der f 1 was considered ($r = 0.53$, $p = 10^{-4}$). Interestingly, however, no correlation was found between the Der p 1 and Der f 1 concentrations within the mattresses, the mattress bases, or the floors;

whereas each of the Der f 1 and Der p 1 concentrations in the different measurement sites were closely correlated, suggesting that the two populations of allergen might grow independently in a given sleeping room.

Results of analyses relating group 1 antigen levels to mattress and dwelling characteristics

The amount of Der p 1 + Der f 1 allergens in mattress bases was not correlated with the age of the mattress, with its size (single or double bed), or with the type of floors, although the amount of Der p 1 + Der f 1 allergens was higher in carpeted floors than in hard floors. Group 1 allergen concentrations in mattress bases did not differ according to type of dwelling or floor level.

DISCUSSION

The main and surprising result of this study was the role of the mattress base as a major reservoir of domestic mite allergens, the allergen content being higher in bases than in mattresses in 44 of 54 dwellings. Encasement of mattresses in such situations appears inadequate and probably would not reduce allergen loads in bedrooms. Changing mattresses without changing bases would lead to a rapid recontamination of new mattresses by mites present in bases.⁵ The large amount of mite allergens found in bases could be the result of either mite populations living in bases where they have found sufficient nutrients and optimal relative humidity or of continuous contamination by mite feces produced yearlong by mite populations living in mattresses. The latter hypothesis can be envisaged when mattress bases are older than the mattresses. In this study we found only seven bases older than mattresses, and four of them had a higher mite allergen content than the mattresses. Because the same predominant species were found in mattresses, bases, and floors, it can be assumed that floor dust samples were contaminated by the whole bed (base and mattress); however, the proximity of bases and floors makes the base a good candidate for the contaminator of floors.

Our study shows for the first time that bases are mite habitats, which had never been identified. There is a need for a better evaluation of all mite reservoirs if we wish to perform successful interventions. Recent studies have shown that in an environment with a high content of house dust mite allergens, chemical treatment of carpets and mattresses⁶ or chemical treatment of carpets

and bedding encasements⁷ was not sufficient to produce a sustained beneficial reduction in mite allergen levels. This could be related to the persistence of reservoirs such as mattress bases, because mites can disperse from one location to another within a short period. To rationalize allergen avoidance, advice should be given concerning mattress bases. Box springs, the usual mattress bases in the United States, can be encased. If encasing does not seem feasible, slatted bases are an alternative.

We thank Dr. Guy Hedelin for skillful assistance with the statistical analysis and Mrs. Béatrice Oesterlé for preparing the manuscript.

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IgE-mediated systemic reactions to gelatin included in the varicella vaccine

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Anaphylactic reactions to measles, mumps, rubella, and the combined measles-mumps-rubella (MMR) vaccines have been frequently reported and have been suggested to be caused by allergy to the egg proteins contained in the vaccines.¹ However, the anaphylactic reactions have been reported to occur after administration of the MMR vaccine in children who tolerated eggs.¹ Recently, Kelso et al.² reported that a patient who experienced anaphylaxis in response to the MMR vaccine had IgE antibodies to gelatin detected by an immunoblotting method. Previously, we found that 10 of the 11 children who experienced anaphylactic reactions to measles or mumps vaccine had anti-gelatin IgE

Abbreviation used

MMR: Measles-mumps-rubella

antibodies, and we assumed that most of the reactions were caused by the gelatin contained in the vaccine.³

In Japan the varicella vaccine that contains gelatin has been licensed for administration to normal and high-risk children since 1986.⁴ This vaccine has protected children against varicella infection. Its safety has been confirmed in clinical trials,⁴ and anaphylactic reactions to this vaccine have not been reported previously.

In this study we report four children who had IgE-mediated systemic reactions to the varicella vaccine. To clarify the relationship between the gelatin in the vaccines and the reactions, we measured the anti-gelatin IgE antibody.

METHODS

Physicians and vaccine manufacturers sent serum samples from four children with anaphylactic reactions to varicella vaccination together with clinical reports to the Japan National Institute of Health. As a negative control, serum samples from 50 children (1 to 4 years old; mean age $\pm$ SD, 2 years 4

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J Allergy Clin Immunol 1997;99:263-4.

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