

Exposure to Indoor Allergens in Homes of Patients with Asthma and/or Rhinitis in Southeast Brazil: Effect of Mattress and Pillow Covers on Mite Allergen Levels

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Key Words

Mites · Asthma · *Dermatophagoides pteronyssinus* ·
Indoor allergens · Mite avoidance

Abstract

Background: Exposure and sensitization to indoor allergens have been associated with the development of asthma and other allergic diseases in many parts of the world. It is important to establish the degree of exposure, and to evaluate whether allergen control measures are effective in a particular area. **Methods:** Concentrations of major allergens of mites, cockroach, cat and dog were measured in dust samples from homes of 24 mite-allergic patients living in Ribeirão Preto, Brazil. Allergen concentrations were quantitated by monoclonal antibody-based ELISA. Mite-impermeable mattress and pillow covers were applied to beds in the homes of 19 of the 24 patients, and group 1 mite allergen levels were measured 1 and 6 months following intervention. **Results:** Patients were exposed to high concentrations of mite allergens in their homes. 87.5% of the homes presented concentrations of group 1 allergens > 10 µg/g of dust in at least one site. Cockroach allergen concentrations were low in most samples. Dog allergen concentrations were

significantly higher in homes with dogs as compared to those without dogs. Mean concentrations of cat allergen were 0.1 µg/g. Mite allergen concentrations in bedding samples dropped from 24 µg/g at baseline to 0.9 and 1.0 µg/g, respectively, 1 and 6 months following encasement of mattresses and pillows. **Conclusions:** Significant mite allergen reduction can be achieved in an area of high degree of exposure to mite allergens. Further studies evaluating the effect of this reduction on symptoms and airway inflammation will be necessary to establish the effectiveness of mite avoidance measures in our area.

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Introduction

Exposure and sensitization to indoor allergens have been associated with the development of asthma and other allergic diseases in many parts of the world [1]. In Brazil, 80 and 55% of children with asthma and/or rhinitis present positive skin prick tests to mites and cockroach, respectively [2]. A dose-response relationship between allergen exposure and development of sensitization has been consistently established for mite and cockroach

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allergens [1, 3]. Strategies for management of allergic patients include recommendations on reduction of allergen concentrations in the environment [4, 5].

Large reductions in mite allergen exposure occur in studies conducted in hospitals or in high-altitude sanatoria [6, 7], resulting in significant improvement of symptoms and nonspecific bronchial hyperreactivity. However, controlled studies in homes of children and adults have provided conflicting results [8]. Recent studies have failed to show major benefits of successful reduction of mite allergens in causing a decrease in asthma or atopic dermatitis symptoms in patients with well-established disease, or in preventing the development of respiratory symptoms, atopic dermatitis or atopic sensitization in early childhood [9, 10]. On the other hand, other well-controlled studies have provided evidence of a beneficial effect [11–16]. Mite avoidance studies have been targeted at reducing allergen levels in the bedroom by applying mite-impermeable mattress and pillow covers to patients' beds and removing carpets, which are established measures for control of dust mite exposure [17].

Assessing allergen exposure and defining which environmental control measures are effective in a particular environment are initial steps to understanding the role of allergen avoidance in causing improvement of symptoms, bronchial hyperreactivity and quality of life in allergic patients. The aims of the present study were to quantitate allergen exposure to mites, cockroach, cat and dog in homes of mite-allergic patients living in Ribeirão Preto, Brazil, and to study the effectiveness of applying mattress and pillow covers to the beds of mite-allergic patients with regard to reducing mite allergen concentrations over time.

Patients and Methods

Patients

Twenty-four patients, aged 4–37 years (13 males), were selected for the present study. Thirteen had asthma and rhinitis, 4 had asthma only, 6 had allergic rhinitis only and 1 had atopic dermatitis. Fourteen of the patients were children 4–13 years old, and 10 were adults, seen at the Allergy Clinic of the School of Medicine of Ribeirão Preto, University of São Paulo, Brazil. Patients were selected based on the presence of a positive skin prick test to a *Dermatophagoides pteronyssinus* extract (Bayer, Spokane, USA; 10,000 AU/ml). All patients or their caregivers gave informed consent to participate in the study. The study was approved by the Ethical Committee of the Clinical Hospital of the institution.

Allergen Concentrations in House Dust Samples

Patients living in Ribeirão Preto, southeast Brazil, had their homes visited for collection of dust samples. Eight of 23 homes were

apartments, and all homes were uncarpeted. Dust collection and preparation of dust extracts were performed according to standard procedures [18]. Briefly, dust samples were collected from four sites in each home, i.e. bedding, bedroom floor, TV room and kitchen, using a portable vacuum cleaner (Electrolux Compact Plus). Vacuuming of bed sheets and pillow covers was performed, followed by vacuuming of the entire mattress surface and both sides of the pillow(s). One hundred milligrams of sieved dust were extracted overnight at 4°C in 2 ml of phosphate-buffered saline, and measurements of major allergens from mites (Der p 1, Der f 1 and group 2), cockroach (Bla g 1 and Bla g 2), cat (Fel d 1) and dog (Can f 1) were carried out using monoclonal antibody-based ELISA, as previously described [18–21].

Effect of Mite-Impermeable Mattress and Pillow Covers on Mite Allergen Levels in Bedding Samples

Mite-impermeable mattress and pillow covers, kindly provided by LUFT (São Paulo, Brazil), were randomly distributed to 19 of the 24 patients, and applied to the mattress and pillow in the patient's bedroom. In keeping with current recommendations for decreasing mite allergen exposure [17], patients from our clinic are routinely instructed to wash bed sheets at least once a week and blankets twice a month, upon diagnosis of mite allergy. Patients in the present study did not receive any further instructions regarding bedding care besides those already provided at clinical visits, and were asked to avoid washing bedding for at least 24 h prior to the home visit. Mite allergen concentrations (Der p 1 and Der f 1) were measured by monoclonal antibody-based ELISA [18] 1 and 6 months following placement of mattress and pillow encasings. A reduction in the concentration of group 1 mite allergens equal to or greater than 90% was considered significant.

Statistical Analysis

The Kruskal-Wallis test was used to compare allergen concentrations in different areas of the home. Comparisons of Der p1 and Der f 1 concentrations in paired samples, and assessment of differences in concentrations of group 1 mite allergens before and after placement of mattress and pillow encasings were carried out using the Wilcoxon test. Concentrations of dog allergen in homes with and without dogs were compared by the Mann-Whitney test. The INSTAT 2 software was used for statistical analysis and the GraphPad Prism 3.0 program was used for construction of graphs.

Results

Levels of Der p 1 and Der f 1 in 93 samples collected from four sites (bedding, bedroom floor, TV room and kitchen) in the homes of 24 allergic patients are shown in figures 1a and b. Der p 1 levels were significantly higher in bedding samples [geometric mean (GM) 1.0 µg/g of dust] as compared to bedroom floor and kitchen samples (GM 0.12 and 0.03 µg/g, respectively; $p < 0.05$). In addition, Der p 1 levels in the TV room (GM 0.54 µg/g) were significantly higher than those in kitchen samples ($p < 0.001$). Similarly, Der f 1 levels were significantly higher in bedding samples (GM 10.2 µg/g) as compared to bedroom

floor and kitchen samples (GM 0.3 and 0.09 µg/g, respectively; $p < 0.001$). Der f 1 levels were also higher in TV room (GM 2.3 µg/g) as compared to kitchen samples ($p < 0.001$). In bedding and TV room samples, Der f 1 levels were significantly higher than Der p 1 levels (Wilcoxon test, $p = 0.003$ and $p = 0.02$, respectively). Group 1 allergens were highest in bedding samples (GM 17.8 µg/g), followed by TV room (GM 2.4 µg/g), bedroom floor (GM 0.3 µg/g) and kitchen samples (GM 0.1 µg/g). Overall, exposure to group 1 allergens at levels >10 µg/g in at least one site was observed in 87.5% of the patients' homes. In addition, there was a significant correlation of levels of group 1 and group 2 allergens in dust samples ($n = 93$, $r = 0.26$, $p = 0.005$, data not shown). Mite allergen concentrations were high and comparable to those reported in other cities in Brazil or in other countries (table 1).

Cockroach allergen concentrations were low, ranging from undetectable (<0.2 U/g) to 14.6 and 9.6 U/g of dust for Bla g 1 and Bla g 2, respectively. Only 20.8 and 12.5%

Fig. 1. Der p 1 (a) and Der f 1 (b) concentrations in dust samples from homes of patients with asthma and/or rhinitis living in Ribeirão Preto, Brazil. Concentrations of Der p 1 and Der f 1 were significantly higher in bedding samples as compared to bedroom floor and kitchen samples ($p < 0.05$). In addition, Der p 1 and Der f 1 levels in TV room samples were significantly higher than those in kitchen samples ($p < 0.001$). In bedding and TV room samples, Der f 1 levels were significantly higher than Der p 1 levels (Wilcoxon test, $p < 0.05$). The number of samples with undetectable levels of allergen (<0.02 µg/ml) is indicated directly below the graphs.

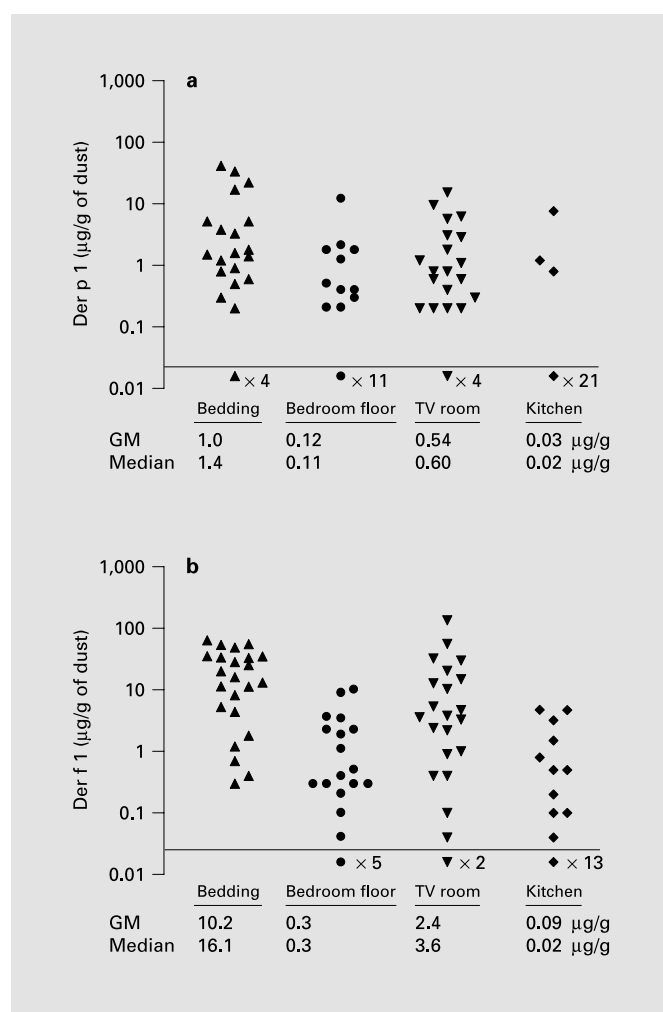


Table 1. Comparison of mite allergen concentrations in dust samples from homes in Ribeirão Preto to concentrations reported from other countries and other areas of Brazil

Allergen	Location	Mean level of mite allergen, µg/g	Report
Der p 1	Poole, England, UK	16.1	Sporik et al. 1990 [22]
Der p 1	Wellington, New Zealand	46.6	Wickens et al. 1997 [23]
Der p 1	Sydney, Australia	38.9	Marks et al. 1995 [24]
Der p 1	Charlottesville, Va., USA	16.6	Sporik et al. 1999 [25]
Der p 1	São Paulo, Brazil	38.4	Arruda et al. 1991 [26]
Der p 1	São Paulo, Brazil	22.2	Rizzo et al. 1993 [27]
Der p 1	Uberlândia, Brazil	2.8	Sopelete et al. 2000 [28]
Der f 1	Uberlândia, Brazil	15.8	Sopelete et al. 2000 [28]
Der p 1	Ribeirão Preto, Brazil	1.0	present study
Der f 1	Ribeirão Preto, Brazil	10.2	present study

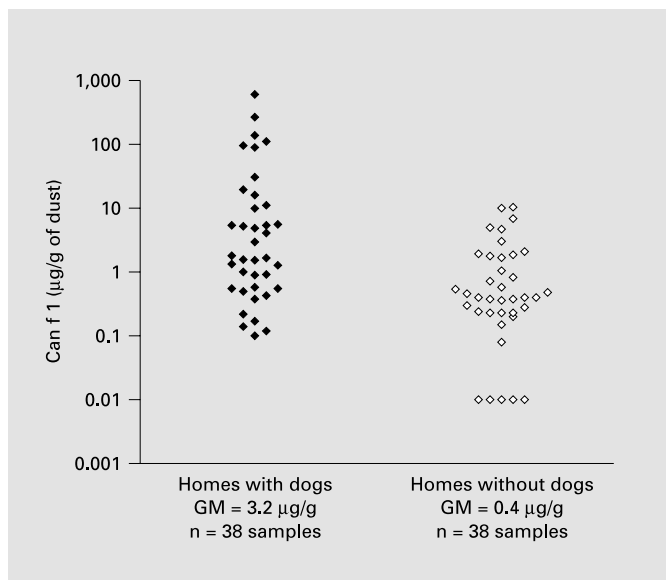


Fig. 2. Concentrations of dog allergen Can f 1 in dust samples from homes with and without dogs. Dog allergen concentrations were significantly higher in samples collected from the 11 homes with dogs as compared to those without dogs ($n = 13$ homes).

of the homes, respectively, contained concentrations of Bla g 1 and Bla g 2 equal to or greater than 8 U/g in at least one site of the home (data not shown). In addition, no significant differences were observed with regard to concentrations in the four sites of each patient's home.

Seventy-six samples were available for Can f 1 measurements. As expected, dog allergen concentrations were significantly higher in samples collected from the 11 homes with dogs, as compared to those without dogs (GM 3.3 and 0.4 µg/g, respectively; $p < 0.0005$) (fig. 2). None of the homes had cats; however, cat allergen Fel d 1 could be detected in very low concentrations in most samples (GM: bedding 0.18 µg/g; bedroom floor 0.07 µg/g; TV room 0.1 µg/g; kitchen 0.03 µg/g) (data not shown).

In a subgroup of 19 of the 24 patients, the effect of mite-impermeable mattress and pillow covers on group 1 allergen concentrations was evaluated. After 1 and 6 months, there was a significant reduction of group 1 mite allergen concentrations in bedding samples (GM 0.9 and 1 µg/g, respectively) as compared to baseline levels (GM 24.2 µg/g; $p < 0.0001$) (fig. 3). Reduction of mite allergen concentrations equal to or greater than 90% was observed in 74 and 68% of the samples analyzed 1 and 6 months, respectively, following the use of encasings.

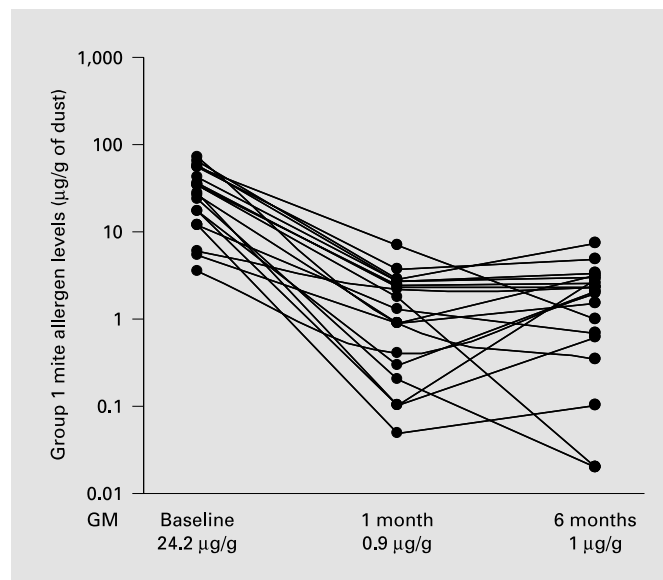


Fig. 3. Effect of mite-impermeable mattress and pillow covers on mite allergen concentrations in bedding samples. After 1 and 6 months, there was a significant reduction of group 1 mite allergen concentrations in bedding samples as compared to baseline levels ($p < 0.0001$).

Discussion

Patients living in Ribeirão Preto have high concentrations of group 1 mite allergens in their beds, as previously shown [24–26]. Placement of mattress and pillow encasings resulted in significant and sustained reduction of mite allergen levels in bedding samples. It would be unlikely that reductions in allergen levels of the magnitude we observed for most samples in our study could have occurred after 1 month, regardless of any intervention. Rizzo et al. [29] analyzed dust samples from homes of mite-allergic children living in the city of São Paulo, Brazil, at monthly intervals over a period of 1 year. They showed that Der p 1 concentrations remained high, without significant variations throughout the study, and that there was no significant correlation of Der p 1 levels with patients' symptom scores [29].

Our previous studies in the city of São Paulo, Brazil, in the early 1990s revealed that children with asthma were exposed to high levels of Der p 1 in their homes, and that Der f 1 levels were undetectable or very low in most samples. However, our current results showed a significantly higher frequency of dust samples containing levels of Der f 1 > 10 µg/ml as compared to Der p 1. Similar results

have also been reported by Sopena et al. [28], studying adult patients living in the city of Uberlândia, Brazil. Differences in climate, housing conditions or lifestyle may account for the variation in the profile of allergen distribution in different cities in Brazil. The results indicate that studies aimed at evaluating environmental exposure to mites in Brazil should include measurements of both Der p 1 and Der f 1 allergens.

Concentrations of cockroach allergens were surprisingly low in our study. Previously, we reported that 55% of children with asthma and/or rhinitis attending Pediatric Allergy clinics in a university setting in Ribeirão Preto and São Paulo presented positive skin prick tests to cockroach (*Blattella germanica* and/or *Periplaneta americana*) [2]. A dose-response relationship between exposure to cockroach allergen in the bedroom and sensitization to cockroach has been determined [3]. In addition, the combination of exposure to cockroach allergens in the home and sensitization has been associated with increased morbidity in children with asthma living in inner cities in the United States [30]. In our community, *P. americana* is the dominant species found indoors. However, assessment of cockroach exposure was carried out by quantitation of *B. germanica* allergens Bla g 1 and Bla g 2, using available assays. Although a homologue of Bla g 1 with a high degree of sequence identity has been described in *P. americana* (Per a 1 allergen) [31, 32], it is possible that our assays have underestimated exposure to cockroach allergens in our area. Alternatively, skin test positivity in our patients may be due to IgE responses to cross-reactive allergens produced by mites. Tropomyosin, a pan-allergen described in cockroaches and other invertebrates, as well as other allergens, may play a role in IgE cross-sensitization [33]. Recently, IgE-binding epitopes were identified in *Blomia tropicalis* tropomyosin (Blo t 10) [34]. This mite allergen shares up to 96% amino acid sequence identity with tropomyosin of *Dermatophagoides* mites [34].

Animal allergens were detectable in most samples in our study. Recently, striking differences have been shown in concentrations of pet allergens in homes in the United Kingdom and in Ghana, Africa. Despite similar rates of pet ownership, concentrations of cat and dog allergens in homes in Ghana were 275 and 75 times lower, respectively, than concentrations in homes with pets in the UK. In addition, allergen concentrations in homes with pets in Ghana were lower than or comparable to those in homes without pets in the UK [35]. Concentrations of dog allergen in homes with dogs in our study were also lower than those in homes in the UK (6.7 times lower), probably due to the fact that in Brazil, as well as in Ghanaian communi-

ties, pets are predominantly kept outdoors. In addition, differences in housing conditions, including the presence of carpets and upholstered furniture, may favor indoor accumulation of animal allergens in homes in the UK. Mean concentrations of cat allergen in homes without cats in our study were comparable to those in homes in Ghana.

In conclusion, we have shown that mite-allergic patients living in Ribeirão Preto, southeast Brazil, are exposed to high concentrations of mite allergens in their homes. Application of antiallergic mattress and pillow covers to the beds of these patients resulted in a substantial decrease in mite allergen exposure in carpet-free bedrooms. Further studies aimed at investigating the role of mite allergen reduction in improving the symptoms and quality of life of mite-allergic patients will be important to determine whether mite avoidance measures are of clinical benefit to patients in our area.

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