House Dust Mite Allergen Levels in A Singapore Hospital

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House dust mites (HDM), especially those of *Dermatophagoides pteronyssinus* and *Dermatophagoides farinae*, constitute one of the most important inhalant allergens in the house dust.¹ Also, there exists a strong association between sensitisation to these allergens and atopic disorders such as asthma.² The warm and humid tropical climate of Singapore is a key factor in promoting mite growth.³ It is not surprising that the major HDM allergens, *Der p I* and *Der f I*, have been found to be highly prevalent in the dust of Singapore homes, with allergen concentrations markedly above the reported sensitising levels of 2 ug per gram of fine dust in the majority of homes.⁴,⁵ Consequently, sensitisation to these HDM allergens has been found to be present in the majority (90%) of our children with asthma.⁶

In this study, we extended our survey of HDM allergen levels⁴,⁵,⁷ to niches within the hospital, in an attempt to obtain information on the levels of allergen exposure in the hospital environment, particularly of our inpatients. Furthermore, a comparison between hospital allergen levels with those of Singapore homes⁵ would enable us to evaluate possible factors affecting the levels of these allergens in our environment. Comparisons made from this work would also compliment our studies on the control of HDM allergens in homes of atopic individuals.⁸,⁹

**SUMMARY** House dust mite allergens constitute one of the most important allergens in house dust. In this study, the levels of two common dust mite allergens, *Der p I* and *Der f I*, in a general hospital in Singapore were evaluated. Our results showed that these allergens were detected in 42/74 (or 57%) of the dust samples. *Der p I* was found to be the predominant allergen detected (p <0.001). The allergen levels were, however, low with only 11/74 having a *Der p I* concentration above 2 μg g⁻¹ dust. None of the samples had *Der f I* concentrations above this level. Of the various niches studied (mattresses, pillows, sofas, carpets, blinds and floors), the blinds and floors had the lowest concentration of allergen (p < 0.05). These low levels in the hospital compared to homes were attributed to the vigorous cleaning schedule in the hospital, the use of plastic to encased mattresses and pillows, vinyl covered sofas and vinyl lined floors. These practices may be adopted in the home as a means to reduce mite allergen exposure.

**MATERIALS AND METHODS**

**Dust samples**
A total of 74 dust samples were collected from the National University Hospital, of which 34 were obtained from various floor locations, 14 from hospital bed mattresses, 10 from sofas used by patients and visitors, and another 16 from various other niches within the hospital (pillows used by patients, carpets in the lobby and restaurant, and curtains). These samples were located in 2 non-air-conditioned wards, 1 air-conditioned ward, and...
air-conditioned outpatient clinic, doctors' offices, the hospital's lobby and restaurant, and ventilated corridors.

Collection of Dust Samples

House dust samples were collected using a Kirby Classic III (Kirby Co, USA) vacuum cleaner. The vacuum cleaner was adapted to collect the dust sample onto a filter paper (Whatman no. 3). The filter paper was supported by a dust trap located at the base of the cleaner attachment. To ensure uniformity in collection, each sample was obtained by vacuuming an area of 1 square meter for 2 minutes. The dust samples were stored at 4°C in a mini-grip lock bag until processed.

Allergen Extraction

Dust samples were sieved through a No. 45 mesh screen with 450 μm pores, (VWR No. 57332146) to remove large particles and fiber. The fine dust was then suspended in borate buffered saline (pH 8.0) containing 0.1% Tween 20 (BBS-T) in a proportion of 100 mg fine dust per 2 ml buffer. For samples containing less than 50 mg of fine dust, 1 ml BBS-T was added. The dust suspensions were mixed end over end in an orbital rotator (Multi-purpose Rotator, Model 151, Scientific Laboratories, Inc, Bohemia, NY 11716) at 4°C overnight. The supernatant was then harvested by centrifugation, and frozen at -70°C until they were assayed for Der p I and Der f I allergens.

ELISA for Der p I and Der f I levels

A sandwich enzyme immunoassay was used as previously described. Briefly, 96 well microtiter plates (Immunolon II, Dynatech, Cantilly, VA) were coated with 1 μg/well of monoclonal antibodies, 5H8 (Der p I) or 6A8 (Der f I) (Chapman MD, Virginia, USA) in 50 mM carbonate-bicarbonate buffer, pH 9.6, overnight at 4°C. After blocking with 1% bovine serum albumin PBS-T, allergen samples were added. Standard curves were constructed using reference D. pteronyssinus or D. farinae extracts (Chapman MD, Virginia, USA). The second antibody, biotinylated 4C1, followed by streptavidin-peroxidase (Sigma) were added after appropriate periods of incubation. Colour development was achieved with 1 mM ABTS in 70 mM citrate phosphate buffer, pH 4.2. The reaction was stopped by adding 0.1 ml 2 mM sodium azide, and absorbance read at 414 mm.

The Chi-square or the Fisher's Exact (2-Tailed) test was used to compare the frequencies and the Spearman's Rank Correlation was used to analyse the correlation between allergen levels.

RESULTS

Hospital furniture and cleaning practices

All the hospital mattresses (full-sized beds and baby cots) were made of latex and were completely encased in thick plastic covers. On the average, bed linens were changed daily. After each patient's discharge, the occupant's bed was stripped of sheets, and the plastic cover damp wiped. Bedside furniture was cleaned similarly. For long-term staying patients, thorough cleaning of furniture was carried out every two to four weeks. Hospital sofas were all vinyl plastic covered and damp wiped once a week.

![Graph showing frequency of Der p I and Der f I allergens detected in 74 dust samples obtained from various locations of the hospital.](image)
Hospital floors were vinyl-lined. The ward and lobby floors were swept and wet mopped twice a day, and daily for floors in clinics, corridors, and offices. Lobby carpets were vacuumed daily and shampooed once a week. The window blinds were made of canvas and cleaned once in 3 months.

**Der p 1 and Der f 1 levels**

Mite allergens were detected in 42/74 (57%) of the samples obtained. Overall, Der p 1 was more prevalent (39/74 or 53%) compared to Der f 1 (19/74 or 26%) (p<0.001). Fig. 1 shows the frequency of Der p 1 and Der f 1 allergens detected in dust samples obtained from the various niches surveyed in the hospital (Fig. 1).

For both allergens, the levels were generally lower on the floors and blinds (Table 1, Figs. 2A, B). Only one sample, obtained from a mattress, contained a Der p 1 level above the reported sensitising level of 2 μg g⁻¹ dust (Fig. 2A). None of the samples had Der f 1 levels above the sensitising levels (Fig. 2B). When comparisons were made between air-conditioned and open wards, no differences were found between allergen levels in samples of comparable niches (mattresses, sofas, carpets, blinds) (data not shown). Allergen levels from the floor were, however, highest in the lobby and office areas compared to the floors of the wards and clinics (p < 0.05) (Figs. 3A, B).

There was no correlation observed between the levels of Der p 1 and Der f 1 in the samples obtained (p > 0.05).

**DISCUSSION**

The HDM, *Dermatophagoides pteronyssinus* and *Dermatophagoides farinae*, have been shown to be amongst the most important allergens causing asthma throughout the world. This is evidenced by the presence of early and late phase re-
responses in the airways following exposure to these allergens, and perhaps more importantly by the higher prevalence of asthma in communities where the mite allergens are prevalent or development of asthma in a population following a change in lifestyle which encouraged mite growth.

The development of monoclonal antibodies to the group I allergens of these mites have provided convenient and more direct means of assessment of mite allergen exposure. In this study, we evaluated Der p 1 and Der f 1 levels in dust samples obtained from a general hospital in Singapore so as to obtain information on allergen exposure to our inpatients.

The Der p 1 (53%) was found more prevalent than Der f 1 (26%) in the dust samples from the hospital, and this distribution is similar to that of the homes in Singapore. This distribution of Der p 1 and Der f 1 allergens locally is comparable to most parts of the world, with the exception of Ohio, USA where Der f 1 was found to be more prevalent. The reason for this geographical distribution of Der p 1 and Der f 1 is uncertain, although the lower humidity in USA favours the growth of D. farinae.

Although there was a relatively high prevalence (57%) of these allergens in the hospital, only one out of the 74 samples had an allergen level above the reported sensitising level of 2 μg g⁻¹ dust (Figs. 2A, B), indicating its presence in low levels in the hospital. In sharp contrast, allergen levels in homes were markedly higher, with 40% of homes having levels above the 2 μg g⁻¹ dust threshold. Similar findings have been reported in a study from the UK, showing lower mite numbers in the hospital compared to the home.

These low allergen levels in the hospital may be attributed to the hospital's cleaning practices and type of furniture used. The use of

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**Fig. 2.** Der p 1 and Der f 1 allergen levels in various floor locations within the hospital. Those samples represented at 0.001 μg g⁻¹ dust of allergen have undetectable levels of allergens.
plastic covers to encase mattresses and pillows, vinyl covers instead of upholstered sofas, and vinyl lined floors in the hospital are important contributing factors. These measures are proven methods for mite avoidance in the home. In fact, mite avoidance studies that have not included the encasement of mattresses in plastic encasing and the removal of carpets have not been successful. The frequent cleaning and changing of bed linen in the hospital are also likely to be important. On the other hand, the use of disinfectants for cleaning is unnecessary to keep mite levels down as this practice had been stopped in our hospital for several years.

Although the overall allergen levels in the hospital were low, significant differences between sampling sites were noted. Lower levels of allergens were found in dust samples from the blinds and floor while those from mattresses and sofas have generally higher allergen levels (Figs. 2A, B). This result is comparative to other mite allergen surveys of homes, where allergen concentrations have been shown to be highest in the mattresses, sofas, and carpets. However, the lower levels of allergens in the hospital carpets, as compared to those at homes where mite allergen levels could reach above 10 μg g⁻¹ fine dust, could be attributed to the rigorous and regular vacuuming and shampooing regime of the carpets in the hospital.

Interestingly, the levels of allergen from floors of the lobby and offices were significantly higher than floor samples from other areas of the hospital (Figs. 3A, B), possibly indicating that the allergen may be brought in from the homes of visitors coming to the hospital. We, however, did not sample allergen levels in the clothing of visitors to confirm this.

The results of this study show that mite allergen levels can be controlled despite the conducive tropical climatic conditions of Singapore, and the presence of considerable human activity in the hospital. The type of furnishings and frequent cleaning measures adopted by the hospital appear to be efficient at controlling HDM allergen levels. These measures should therefore be enforced in the home.

**ACKNOWLEDGEMENTS**

This study was sponsored by research grants from the National Science and Technology Board, and the Singapore Paediatric Society.

**REFERENCES**


