

Measurements on mite allergens in houses of allergy patients in Japan

F. Shinohara^a, H. Miyazawa^b, T. Iwata^{c,*}, H. Yasueda^d, Y Nagase^e

^a*Sekisui House, Ltd., Osaka, Japan;* ^b*Department of Medical Technology, Kyorin University School of Health Sciences, Tokyo, Japan;* ^c*Department of Architecture, Tokai University, Tokyo, Japan;* ^d*Clinical Research Center for Allergy and Rheumatology, National Sagami Hospital, Kanagawa, Japan;* ^e*Nishihara Engineering Co., Ltd. Tokyo, Japan*

ABSTRACT

In order to identify the effects of various kinds of floor materials and that of humidity on the concentration of mite allergens in houses of allergy patients, measurements were carried out in two houses near Tokyo in August, November and December 2001. Temperature, humidity and mite allergens, *Der p* 1, *Der f* 1 and *Der* 2, were measured and a questionnaire survey was conducted. Floor (in living rooms, Japanese tatami-mat rooms and bedrooms) and bedding dust was collected by a vacuum cleaner, and the concentrations of mite allergens in house dust were measured by fluorometric sandwich ELISA.

A high degree of correlation between *Der* 2 and *Der* 1 was found. The concentration of *Der* 1 was higher than that of *Der* 2. A high concentration of *Der p* 1 was found in the carpets while *Der f* 1 showed high concentration in the Japanese tatami-mats. When the relative humidity is less than 50%, concentration of the mite allergen was low. The percentage of *Der p* 1 in *Der* 1 for the carpet was higher than that for the Japanese tatami-mats. The frequent cleaning could reduce the concentration of mite allergens. The supplementary experiment showed that the more fine dust on the floor a larger mass of the mite allergen per unit mass of the fine dust was induced.

INDEX TERMS

Dust mites; Relative humidity; Floor material; Allergen

INTRODUCTION

In Japan, allergies caused by fungi and house dust mites have become serious problems. Allergies to mite allergens are fairly common in the atopic population. House dust mites have been identified in most parts of the world. In temperate climates the highest numbers are found in summer. In tropical countries high numbers of mites can generally be found throughout year. Japan takes the middle position between a temperate climate and a tropical one. Environmental conditions influence also the species distribution, e.g. *Dermatophagoides pteronyssinus* in continuously humid condition and *D. farinae* in dry condition.

It is also said that a higher number of mites can usually be found in mattresses, beddings, pillows and carpeting (Maroni *et al.*, 1995). In Japan, tatami-mat and Futon (Japanese bedding filled with cotton wadding) are used.

In our previous study, field measurements were conducted to identify the kinds of house dust mites in houses in Japan (Shinohara *et al.*, 2001). The number of *Pyroglyphidae* was higher than the other families. The effects of floor materials, temperature, humidity, frequency of cleaning rooms on the mite numbers were examined and it was found that the frequency of cleaning could reduce the mite numbers. However, the mite number cannot indicate health effects directly because mite allergen levels in house dust do not correlate well with mite numbers in house dust (Irie, 1991). As the allergens have been shown to be stable

* Corresponding author. E-mail: iwata@keyaki.cc.u-tokai.ac.jp

for at least 4 years the number of live mites at any given period may bear little correlation with the quantity of allergen present (Howieson *et al.*, 2002).

The purpose of this study was to identify the relationship between allergen levels and floor materials, temperature, humidity, frequency of cleaning rooms in practical conditions. In this paper, field measurements in houses of allergy patients in Japan are reported.

METHODS

In two houses shown in Table 1, measurements were conducted in August, November and December 2001. A questionnaire survey was also conducted in August. In both houses the allergic patients, whose principal sources of allergens had not been identified, are living.

Table 1 Outline of houses

	Prefecture	Age (years)	Number of occupants	Floor material			
				Living and dining room	Japanese room	Bedroom	Bedroom
House A	Kanagawa	30	5	Flooring	Tatami	Carpet	Carpet
House B	Kanagawa	10	5	Flooring	Tatami	Tatami	Tatami

Dust samples were collected with a vacuum cleaner (200 W of work efficiency) under the conditions in which the all openings were closed. The dust was sampled from the floor of the rooms and closets for storing futon, futon, pillows and filters of air-conditioning systems.

The major house dust mite allergens are *Der* 1 (faecal allergen) which contains *Der p* 1 (*D. pteronyssinus*) and *Der f* 1 (*D. farinae*), and *Der* 2 (derived from body of mite). The allergens *Der p* 1, *Der f* 1, and *Der* 2 were purified according to the previous study (Yasueda *et al.*, 1986, 1989). *Der p* 1, *Der f* 1 and *Der* 2 were quantified using a fluorometric sandwich ELISA. Figures 1 and 2 show the process of the analysis, sieving dust and adding diluted sample to the wells of flat-bottomed ELISA plates.

Air temperature and relative humidity were recorded every 5 min in each room. Air change rate was measured in December by using the PFT method.



Figure 1 Sieving dust.



Figure 2 Adding diluted sample to the wells of flat-bottomed ELISA plates.

RESULTS

Difference between Seasons and Between Rooms

Figures 3 and 4 show the concentrations of mite allergens in fine dust. In House A, seasonal difference cannot be found significantly. In House B, house mite allergens reduced from summer (August) to autumn (November) and increased from autumn to winter (December).

In both houses lower concentrations of house dust allergens were shown in the living and dining rooms and the Japanese rooms in all seasons, while higher concentrations were found in the bedrooms, the closets for storing futon, the futon and the pillows. However, allergens found in the Futon in this study were lower than the results shown by the previous study in

Japan (Miyazawa *et al.*, 1996), which showed 80 $\mu\text{g/g}$ of fine dust in August, 51 $\mu\text{g/g}$ of fine dust in November and 42 $\mu\text{g/g}$ of fine dust in December as geometric means of eight sampled houses. The pillow in House B in summer showed very high levels because the wadding of the pillow was chaff of buckwheat. The filters of air-conditioning showed low concentration.

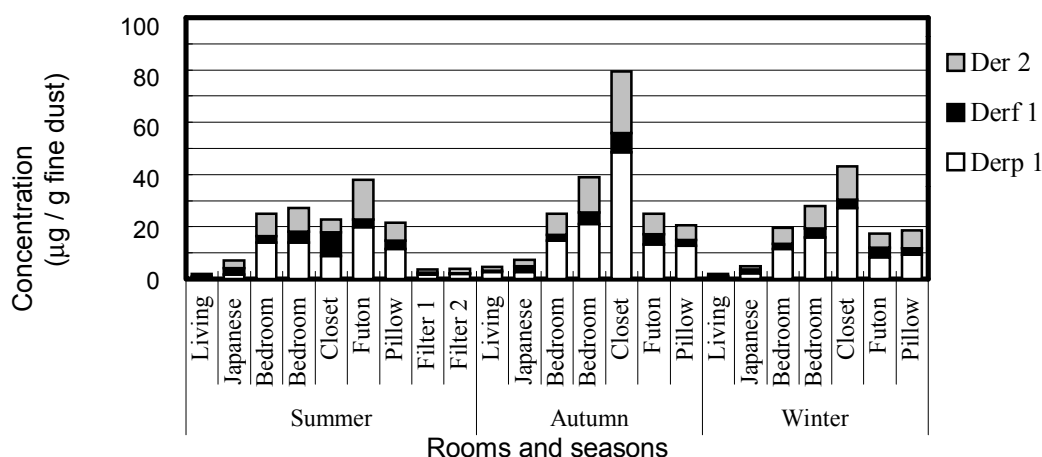


Figure 3 The concentrations of mite allergens in fine dust in House A.

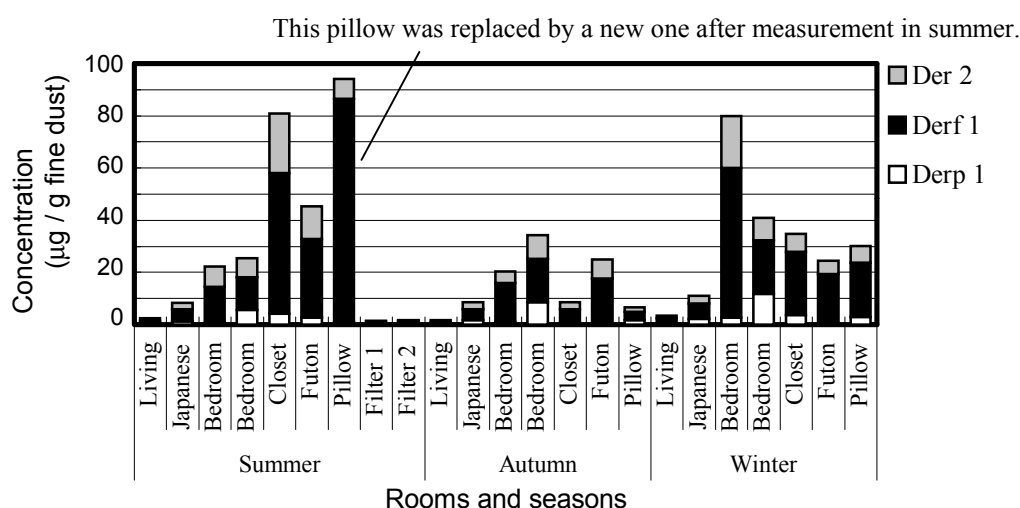


Figure 4 The concentrations of mite allergens in fine dust in House B.

Kinds of Allergens

As shown in Figures 3 and 4, *Der 1* showed higher concentration than *Der 2* in both houses. In House A, *Der p 1* showed higher concentration than *Der f 1* while *Der f 1* showed higher concentration than *Der p 1* in House B. For *Der p 1*, in summer the dust in all the rooms contained higher concentration than WHO sensitization threshold of 2 $\mu\text{g/g}$ of house dust and the dust in the bedrooms contained higher concentration than the upper threshold of 10 $\mu\text{g/g}$ of house dust in all seasons.

Aside from mite allergens in the pillow which were extremely high, a high degree of correlation between *Der 2* and *Der 1* was found. It was also found that the concentration of *Der 1* showed higher than that of *Der 2*.

The Effects of Temperature and Humidity on Allergen Levels

The air change rate in House A ranged from 0.87 to 1.75 (h^{-1}) while that in House B ranged from 0.41 to 0.55 (h^{-1}). No correlations were found between the air change rate and temperature and humidity.

No strong correlation was found between allergen concentrations in house dust and temperature and humidity (both relative and absolute humidity). Even around an air temperature of 15°C, a high mite allergen concentration was shown. However, a high concentration was not found at less than 50% of relative humidity. Although Gunnarsen *et al.* (2002) showed a significant correlation between mite concentration in beds and absolute humidity, the effects of absolute humidity on the concentration of mite allergen were not found in this study.

Relationship between Floor Materials and Dust Mite Allergens

Figure 5 shows the relationship between floor materials and the concentration of mite allergen. A high mite allergen concentration was found in dust on carpet and on tatami-mat while a low concentration was found in dust on flooring. This result is similar to our previous study in which the number of mites was counted (Shinohara *et al.*, 2001).

There was no difference in the ratio of *Der* 1/*Der* 2 between different floor materials. *Der p* 1 showed a high concentration in dust on the carpets while *Der f* 1 showed high concentration in dust on the Japanese tatami-mats. A significant difference in the percentage of *Der p* 1 in *Der* 1 ($(\text{Der } p \text{ 1} / \text{Der } 1) \times 100$) was found between the carpets and the tatami-mats (1% level). The fact that the rooms in House A had carpet rather than tatami-mat can be a possible reason why the concentration of *Der p* 1 was higher than that of *Der f* 1 in House A and the opposite could be shown in House B, as shown in Figures 3 and 4.

Figure 6 shows the relationship between humidity and the percentage of *Der p* 1 in *Der* 1. The percentage of *Der p* 1 for the carpet was higher than that for the tatami-mats. The higher the humidity becomes, the higher the percentage of *Der p* 1 for tatami-mat becomes.

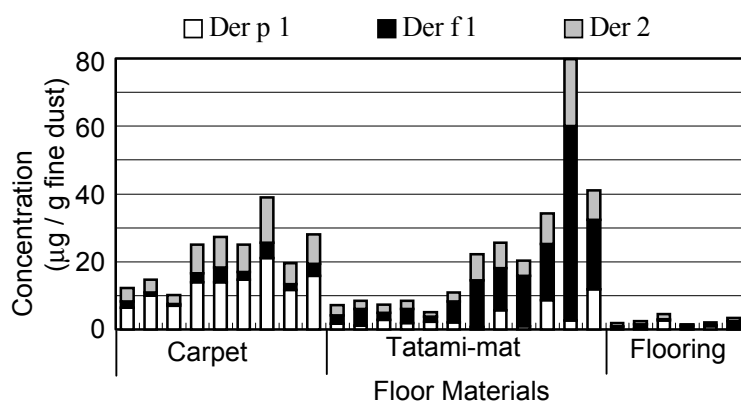


Figure 5 Mite allergens in house dust on different floor materials

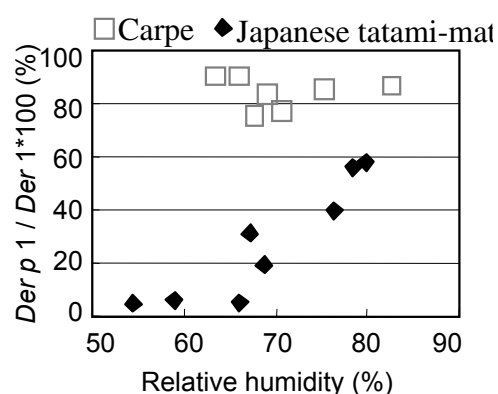


Figure 6 Relative humidity vs. % of *Der p* 1 in *Der* 1.

Relationship between the Frequency of Cleaning and Dust Mite Allergens

Figure 7 shows the relationship between the frequency of cleaning a room and mite allergen concentration in house dust. It was shown that a high frequency of cleaning a room could reduce the concentration of mite allergens, both *Der* 1 and *Der* 2, especially *Der f* 1. Generally, mite allergen concentration is indicated by weight of allergen per unit mass of fine dust (less than 0.3 mm). If less frequency of cleaning brings more house dust including fine

dust, it would induce an exponential increase in the mass of mite allergen which equals allergen concentration multiplied by the mass of fine dust.

Mass of the Fine Dust and the Concentration of Allergen

Since the mass of fine dust (g/m^2 floor area) was not quantified in the present field investigation, a supplementary experiment was conducted to identify the relationship between the elapsed time, which was the period from the last cleaning to the sampling, and the mass of fine dust, as well as the relationship between the mass of fine dust and the allergen concentration in the fine dust.

The experiment was conducted in two bedrooms in two houses (House C and House D). The house dust was thoroughly vacuumed at three different intervals, 2, 4 and 8 days after the last cleaning. The area of the floor that was cleaned, the mass of the house dust vacuumed and the mass of fine dust (less than 0.3 mm) were measured. Although a strong correlation was found between the mass of the house dust and that of the fine dust as shown in Figure 8, the effect of the elapsed time from the last cleaning on the mass of house dust was not clarified. Therefore, the relationship between the elapsed time from the last cleaning and the mass of fine dust could not be identified.

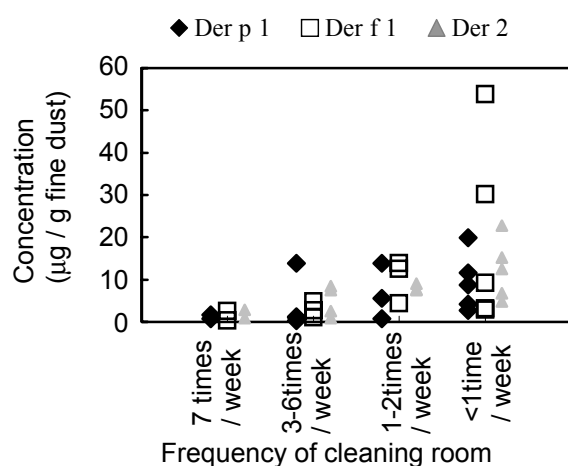


Figure 7 Frequency of cleaning room vs. mite allergen concentration.

Figure 9 shows the relationship between the mass of fine dust and mite allergen concentration in house dust. The more fine dust on the floor would mean a large mass of mite allergen per unit mass of the fine dust.

DISCUSSION

In this study, seasonal difference, the effects of floor materials, temperature, humidity, frequency of cleaning on the mite allergen concentration were tested and several findings were obtained as mentioned in the Conclusions.

However, these results are rather relative because fundamentals have not yet been identified sufficiently in this field, e.g. mite allergen is indicated in weight of allergen per unit mass of the fine dust (or the house dust) which is different from the total amount of allergen (absolute amount). The supplementary experiment showed that the more fine dust on the floor induced

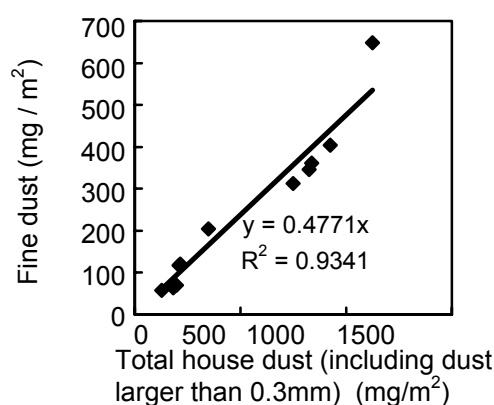


Figure 8 House dust vs. fine dust.

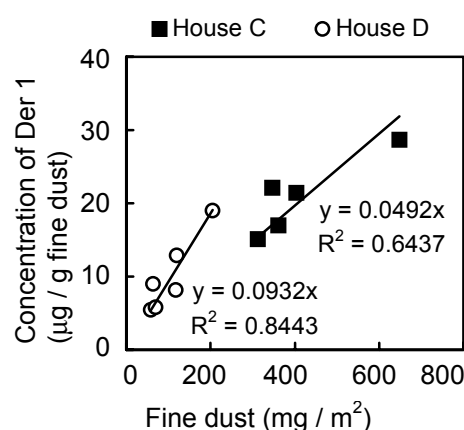


Figure 9 Fine dust vs. mite allergen concentration.

a large mass of the mite allergen per unit mass of the fine dust. Therefore, the mass of fine dust per unit area should be measured to evaluate the total mass of allergen.

CONCLUSIONS

Field investigation of house dust mite allergens in houses of allergy patients were conducted and the following conclusions were obtained:

1. A significant seasonal difference could not be obviously found.
2. A high degree of correlation between *Der 2* and *Der 1* was found. The concentration of *Der 1* was higher than that of *Der 2*.
3. A high concentration of *Der p 1* was found in the carpets while *Der f 1* showed high concentration in the Japanese tatami-mats.
4. The supplementary experiment showed that the more fine dust on the floor induced a larger mass of the mite allergen per unit mass of the fine dust.

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