Brief Report

DOI: 10.5582/bst.2012.v6.1.7

# A study on indoor environment contaminants related to dust mite in dwellings of allergic asthma patients and of healthy subjects

**Meng Feng[1], Bing Yang[1], Yijun Zhuang[1], U Yanagi[2], Xunjia Cheng[1,*]**

[1] *Department of Microbiology and Parasitology, Shanghai Medical College of Fudan University, Shanghai, China;*
[2] *Department of Architectural Hygiene and Housing, National Institute of Public Health, Wako, Saitama, Japan.*

**Summary** **This study investigated the pollution of dust mite allergens in the houses of 30 families and their infection to young allergic asthma patients in Shanghai. Medical records, family information, and dust samples were collected from the dwellings of 15 young allergic asthma patients and 15 healthy subjects. Der 1 allergen, which is a common allergen causing allergic asthma, was measured in collected dust samples using the Pharmacia Uni-CAP System. A significant correlation was found between the number of Der 1 allergens collected from floor surfaces and the number of Der 1 allergens collected from bed surfaces. Some factors influencing Der 1 allergen levels were found in this study. Relative humidity in dwellings was found to be most influential to the allergen levels. The findings suggested that traditional reduction methods for coarse particles, such as opening windows and periodic cleaning of beddings, may be effective in removing dust mite allergens.**

***Keywords:*** Dust mite, dust mite allergen, allergic asthma, Der 1, indoor, dwelling

## 1. Introduction

Allergic diseases, especially asthma, are public health problems worldwide. In most countries, the spread and mortality cases of asthma are continuously increasing. The World Health Organization (WHO) estimated 300 million asthmatic patients around the world, with incidence ranging from 1% to 18%. More than 50% of adult patients and 80% of young patients are sensitive to allergic factors (*1,2*).

Dust mite allergen is not only a familiar indoor allergen, but is also one of the most important pathogens causing allergic asthma (*3-6*). Dust mites belong to Acariformes, Acaroidea, Pyroglyphidae, and Pyroglyphidae, including Pyroglyphinae and Dermatophagoidinae. More than 10 genera and 40 species of dust mites exist all over the world. Two of the most important strains are *Dermatophagoides pteronyssinus* (D.p) and *Dermatophagoides farinae* (D.f). D. *pteronyssinus* is one of the first advantaged dust mites found in Eurasia, whereas D. *farinae* is the advantaged dust mite common in America (*7,8*).

Data reveal that China's cities are seriously polluted by dust mite allergens (*9*). A research on dust mites in 15 cities in China showed that house dust mites thrive in over 40% of houses in cities, except in high latitude areas, such as Zhangjiakou and Akesu. House dust mites were also found in 67% of houses in Shanghai (*10*).

Allergic asthma is a disease threatening human health which involves long-term treatment and high costs. Dust mite allergen is one of the most important pathogens causing allergic asthma, which exist in every part of the house. Thus, effectively decreasing indoor dust mite allergen levels can actively contribute to the prevention and treatment of allergic asthma. The objectives of this study are to determine the pollution caused by dust mite allergens in dwellings in Shanghai and to formulate a control method which will reduce indoor air pollution related to dust mite allergens.

## 2. Materials and Methods

This observational testing and analysis study evaluated indoor air contaminants related to dust mite from 2006

**Address correspondence to:*
Prof. Xunjia Cheng, Department of Medical Microbiology and Parasitology, Shanghai Medical College of Fudan University, Shanghai 200032, China.
E-mail: xjcheng@shmu.edu.cn

to 2007 in dwellings located in Shanghai. Similar with a related research (*11*), the present study gathered 15 young allergic asthma patients hospitalized in public pediatric clinics in Shanghai. The parents or legal guardians of eligible child subjects received detailed orientation on the aim of the study. Subjects were selected according to the following criteria: aged 1-16 years old, resident of Shanghai, reported with allergic asthma, income, and house types. Another set of 15 healthy subjects was chosen to participate in the study as control. The healthy subjects were selected based on the same criteria as the allergic asthma patients. Measurements were taken in the living room of each of the subject's dwellings.

A questionnaire survey was also carried out, which focused on medical records, house conditions, and lifestyles. Necessary information was inquired and documented in detail.

The indoor air temperature and relative humidity in each dwelling were measured by a hygrothermograph (THERMO RECORDER RS-11) positioned at the center of the living room. After a waiting time of two minutes, the data were read and recorded.

After measuring air temperature and relative humidity, house dust was collected from the surfaces of living room beds and floors using a paper filter equipped with a hand cleaner (HC-V15, National). The hand cleaner instantly absorbed house dust from the beds and floors. Subsequently, the collected samples of house dust were placed in a paper filter every minute. The samples were labeled and used for the analysis of dust mite allergen levels using the Pharmacia Uni-CAP System. The Pharmacia Uni-CAP System identified the dust mite allergen levels of the dust samples and automatically printed the results.

Results were tabulated and analyzed as μg/g fine dust for the dust mite allergen, Der 1. The levels of the allergen were compared based on geographical location, sampling locations, air temperature, and relative humidity.

The different parameters did not approach a normal distribution, even after log transformation. Non-parametric Mann-Whitney *U* test was used to evaluate the correlation between the dwellings of allergic asthma patients and those of healthy subjects in different sampling locations.

Correlations between Der 1 levels and temperature and relative humidity were assessed by means of the Spearman correlation coefficient (rho). The limit of significance was 0.05. Statistical analysis was performed with SPSS for Windows.

### 3. Results and Discussion

A total of 30 dwellings were assessed in this study: 15 dwellings of young allergic asthma patients and 15 dwellings of healthy subjects. Investigations conducted in each dwelling were successfully completed, and results were collected.

Der 1 mite allergens were detected in 100% of the analyzed dust samples ($n$ = 60) collected from the dwellings. In dwellings of young allergic asthma patients, the level of Der 1 on the surfaces of living room beds varied widely from 0.06 μg/g to 21.30 μg/g (geometric mean: 1.74 μg/g). The Der 1 level on bed surfaces was higher than that on the surfaces of living room floors ($p < 0.001$), which ranged from 0.03 μg/g to 2.09 μg/g (geometric mean: 0.34 μg/g) (Figure 1). In the dwellings of healthy subjects, the level of Der 1 collected from the surfaces of living room beds varied widely from 0.65 μg/g to 69.33 μg/g (geometric mean: 7.14 μg/g), which was higher than the Der 1 level on the surfaces of living room floors ($p = 0.045$) that ranged from 0.01 μg/g to 22.22 μg/g (geometric mean: 2.05 μg/g) (Figure 1). In comparison, significantly higher levels of Der 1 were found in dwellings of healthy subjects than in dwellings of allergic asthma patients ($p < 0.001$).

Factors such as medical records of young allergic asthma patients, building structures, and family lifestyles were examined to determine their effects on Der 1 allergen levels; data came from the questionnaire survey. No association was found between the concentration of mite allergens and environmental characteristics, such as type of ventilation, lifestyles, and building structures.

Air temperature in the dwellings of allergic asthma patients ranged from 18.1°C to 21.6°C (mean: 19.9° C), whereas relative humidity ranged from 60% to 75% (mean: 69%). Air temperature in the dwellings of healthy subjects ranged from 19.7°C to 24.2°C (mean: 21.6°C), whereas relative humidity ranged from 41% to 62% (mean: 49.4%). The average air temperature in the patients' dwellings was lower than that of the healthy subjects' dwellings. A significant relationship was found between relative humidity and Der 1 levels on bed surfaces in patients' dwellings ($r = 0.577$; $p = 0.024$) (Figure 2), whereas no obvious correlation was found between relative humidity and Der 1 levels on bed surfaces in the dwellings of healthy subjects.

The dwellings of six families who use cleaners reflected higher Der 1 levels compared with those of the nine families who do not use cleaners. A significant relationship between the usage of cleaners and Der 1 levels on bed surfaces was determined. Der 1 levels were evidently high in dwellings of families using cleaners. On the other hand, statistical analysis indicated a high Der 1 level when relative humidity was high. Thus, relative humidity may be the most important factor affecting Der 1 level and also decreases the influence of other factors.

The significantly higher levels of Der 1 in the dwellings of healthy subjects compared with those of allergic asthma patients could be attributed to the attention given to the conditions of their houses. Families of allergic asthma patients apparently spent more time in house cleaning to reduce further exposure of their children to dangerous allergens. Another possible reason

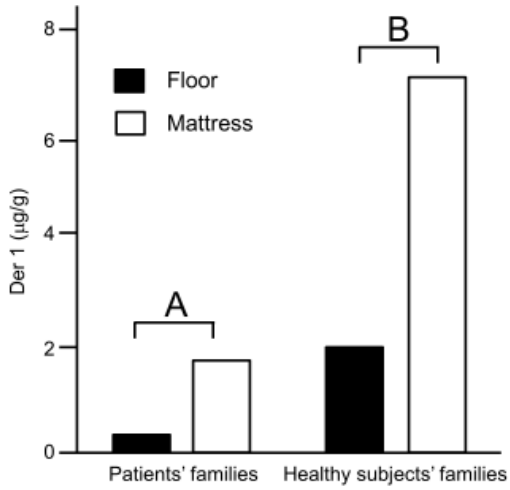


**Figure 1. The geometric mean of Der 1 concentrations in dust samples.** Black pillar indicates dust samples collected from floor and white pillar indicates dust samples collected from mattress. **(A)** Dust samples collected from the dwellings of allergic asthma patients (mattress *vs.* floor surfaces: $p < 0.001$). **(B)** Dust samples collected from the dwellings of healthy subjects (mattress *vs.* floor surfaces: $p < 0.001$).

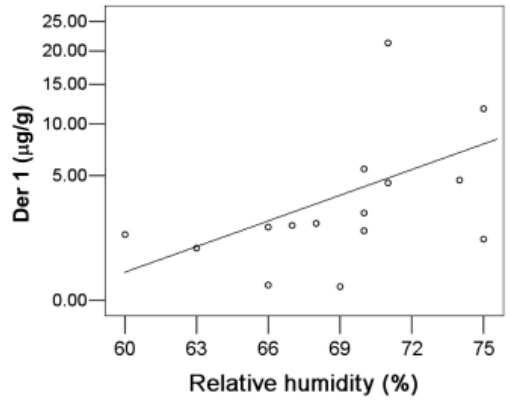


**Figure 2. Correlation between Der 1 levels of dust samples collected from the dwellings' mattress of allergic asthma patients and indoor relative humidity ($r = 0.577$; $p = 0.024$).**

could be the occurrence of allergic symptoms or allergic asthma among patients even from only a few dust mite allergens.

Der 1 levels, as well as relative humidity, in the dwellings of two healthy subjects were especially higher than those in others. The higher Der 1 levels may be erroneously caused by a technician feeding dust mites as their jobs in each of the two families. However, the result may also be attributed to high relative humidity. Further study is necessary to verify this.

The geometric mean level of Der 1 collected from the surfaces of living room beds was higher than that collected from the surfaces of living room floors. This finding implied that maintaining an orderly bed and periodic cleaning of beddings were of more concern for families with members who had allergic asthma.

From the present study, relative humidity was found to be the most significant factor affecting indoor dust mite levels. Yanagi *et al.* (*11*) reported the relationship between ventilation, purification, and relative humidity. Relative humidity decreased sharply after opening windows and normalized quickly as time elapsed. Therefore, opening windows (*e.g.* once per hour) is effective in reducing indoor relative humidity and dust mite levels.

**Acknowledgements**

This work was supported by grants from the National Science Foundation for Fostering Talents in Basic Research of the National Natural Science Foundation of China (Grant No. JO730860), and the Hi-Tech Research and Development Program of China (Grant No. 2007AA02Z472), and the Special Research Foundation of the Health Industry (Grant No. 200802001).

**References**

1. Global Initiative for Asthma (GINA). The Global Strategy for Asthma Management and Prevention. *http://www.ginasthma.org* (accessed August 22, 2011).
2. GINA reports: Global Burden of Asthma. *http://www.ginasthma.org* (accessed September 12, 2011).
3. Thomas WR, Smith WA, Hales BJ, Mills KL, O'Brien RM. Characterization and Immunobiology of House Dust Mite Allergens. Int Arch Allergy Immunol. 2002; 129:1-18.
4. Hales BJ, Martin AC, Pearce LJ, Laing IA, Hayden CM, Goldblatt J, Le Souëf PN, Thomas WR. IgE and IgG anti-house dust mite specificities in allergic disease. J Allergy Clin Immunol. 2006; 118:361-367.
5. Weghofer M, Thomas WR, Pittner G, Horak F, Valenta R, Vrtala S. Comparison of purified Dermatophagoides pteronyssinus allergens and extract by two-dimensional immunoblotting and quantitative immunoglobulin E inhibitions. Clin Exp Allergy. 2005; 35:1384-1391.
6. Pittner G, Vrtala S, Thomas WR, Weghofer M, Kundi M, Horak F, Kraft D, Valenta R. Component-resolved diagnosis of house-dust mite allergy with purified natural and recombinant mite allergens. Clin Exp Allergy. 2004; 34:597-603 .
7. Li YL. Human parasitology. 6th ed., People's Medical Publishing House, Beijing, China; pp. 271-272.
8. Mihrshahi S, Marks G, Vanlaar C, Tovey E, Peat J. Predictors of high house dust mite allergen concentrations in residential homes in Sydney. Allergy. 2002; 57:137-142.
9. Gui YY, Tang HW, Zhang XC, Liu JH, Wen TH. Investigation about dust mites in people's house in Zhangjiakou. Transaction of Zhangjiakou Medical College. 1994; 11:41-42. (in Chinese)
10. Platts-Mills TAE, de Weck AL. Dust mite allergens and asthma – a worldwide problem. J Allergy Clin Immunol. 1989; 83:416-427.
11. Yanagi U, Ikeda K, Kagi N, Sakaguchi M, Arashima Y. A Study on indoor air contaminants related to pets in Japanese dwellings. Journal of Asian architecture and building engineering. 2006; 5:355-360.

(*Received November 30, 2011; Revised January 30, 2012; Accepted February 12, 2012*)