

Measurement of Allergens Associated with Dust Mite Allergy

II. Concentrations of Airborne Mite Allergens (*Der I* and *Der II*) in the House

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Abstract. Assays of mite allergens (*Der p I*, *Der f I* and *Der II*) in the air of houses became feasible with the use of a low-noise air sampler and a sensitive radioimmunoassay described previously. The levels of the airborne allergens *Der I* (*Der p I* + *Der f I*) and *Der II* in the living room of 10 houses during usual domestic life were very low, 29.5 and 6.3 pg/m³, respectively, with a *Der I*:*Der II* ratio of 4.7:1. At the time of bedmaking, they greatly increased, about 1,000-fold, to 30,900 and 12,600 pg/m³, respectively, with a *Der I*:*Der II* ratio of 2.5:1. The amounts of *Der I* and *Der II* in the floor dust of the living room were 2,040 and 2,690 ng/g of fine dust, respectively, with a *Der I*:*Der II* ratio of 0.8:1. *Der I* seemed more prone to become airborne than *Der II*.

Introduction

Allergy to house dust allergens is common among patients with bronchial asthma and allergic rhinitis. It has been well established that two species of the mite genus *Dermatophagoides*, *D. pteronyssinus* and *D. farinae*, are an important source of house dust allergens [1-3]. Two groups of major allergens, the *Der I* and *Der II* groups, have been purified from each *Dermatophagoides* species [4-7].

Tovey et al. [8] measured the allergen level of *Der p I* in the air of houses, and detected the allergens in a disturbed, but not in an undisturbed, condition [8]. The levels of the allergens present on the floor and bed of a house are mainly influenced by the indoor climate, the kind of the floor and the inhabitants themselves [9]. On the other hand, it seems that the allergen levels in the air might be strongly influenced by the human activity in the room [8].

The purpose of this investigation was to determine the levels of mite allergens (*Der I* and *Der II*) both in the air and on the floor of houses. Conventional air samplers are too noisy to be operated for a long period inside houses. Furthermore, the assay methods for allergens have not been sensitive enough to detect airborne allergens in such a relatively calm condition

as during ordinary life in living rooms. We have overcome these difficulties by the use of a new low-noise air sampler and a more sensitive radioimmunoassay [10], and hence could measure mite allergens in the air of the house in the calm condition.

Materials and Methods

Air-Sampling Equipment

A new low-noise portable air sampler (KI-636, Dylec, Tokyo, Japan) was used for collection of airborne particles. The sampler (24 cm × 40 cm × 32 high and weight of 9.5 kg) is covered with a thick sound-absorbing material. During operation, the noise level is less than 50 dB and the flow rate is 6 liters/min, which is equivalent to the normal respiratory air volume of adults. In the top surface, there is a roofed orifice through which all the airborne particles are collected on a 37-mm diameter fiber glass filter (AP 40, Millipore, Bedford, Mass., USA) that retains particles of ≥ 0.3 μm.

Air Sampling

Samplers for aeroallergens were obtained from 10 families, selected without regard to the children's allergy histories, living in concrete-built apartments at a public housing area in Yokohama consisting of 20 buildings of 5, 8 and 11 stories in height with about 1,000 homes which almost belong to the middle class in Japan. Each family consisted of 1 couple with 1 or 2 children who were from 0 to 4 years old. One child in home C had allergic rhinitis caused by the mite, and all other children had no apparent mite-related allergic rhinitis and asthma.

Table 1. Airborne and floor dust allergens in the living room during usual domestic life

Home	Aeroallergens, pg/m ³					Dust allergens, ng/g fine dust				
	<i>Der p</i> I	<i>Der f</i> I	<i>Der</i> I ^a	<i>Der</i> II	I/II ^b	<i>Der p</i> I	<i>Der f</i> I	<i>Der</i> I ^a	<i>Der</i> II	I/II ^b
A	45.0	4.9	49.9	12.3	4.1	429	222	651	648	1.0
B	94.0	9.9	104.0	14.0	7.4	600	644	1,244	3,020	0.4
C	107.0	8.8	116.0	35.1	3.3	10,100	1,510	11,600	10,800	1.1
D	6.7	0.9	7.6	2.5	3.0	3,270	790	4,060	2,930	1.4
E	5.1	3.2	8.3	2.5	3.3	379	373	752	1,010	0.7
F	26.3	2.1	28.4	7.5	3.8	1,260	192	1,450	2,960	0.5
G	19.0	0.4	19.4	6.8	2.9	2,400	419	2,820	4,240	0.7
H	29.1	1.4	30.5	3.5	8.7	4,000	607	4,610	5,620	0.8
I	8.7	1.0	9.7	1.7	5.7	673	116	789	1,340	0.6
J	2.8	82.3	85.1	9.1	9.4	89	2,810	2,900	3,140	0.9
Geometric mean			29.5	6.3	4.7			2,040	2,690	0.8

^a *Der p* I and *Der f* I add up to *Der* I.

^b Ratio of *Der* I to *Der* II.

The air sampling was conducted in two conditions during July and August 1988. In the first, undisturbed, condition, the air sampler was placed on the floor in a corner of the living room, and the air was collected during usual domestic life. Sampling time varied from 109 to 124 h, which represents suctioned air volumes of 39.2–44.6 m³. In the second, disturbed, condition, the samples were obtained in the bedroom. The sampler was placed on the floor of the bedroom for 40 min, including 5–10 min of bedmaking [unfolding and shaking two sets of sheet, blanket and futon (Japanese bed quilt) according to the routine in each home].

Filter Extraction for Aeroallergen Quantitation

The allergens collected on the filter were extracted with 6 ml of 0.125 M NH₄HCO₃ supplemented with 0.01% bovine serum albumin (BSA) for 2 h at room temperature on a shaker and then overnight at 4°C. After low-speed centrifugation, the supernatant was lyophilized, and then reconstituted in 1.5 ml of phosphate-buffered saline (PBS) containing 0.05% Tween 20 and 1% BSA. This concentrate was used as an aeroallergen sample.

Dust Samples

Dust from the floor and the Japanese quilt was collected with a vacuum cleaner (HC-V10, National, Osaka, Japan), fitted with a filter holder. The dust was mixed and shaken with glass beads (5 mm in diameter), then sieved through a 0.3-mm mesh screen to obtain the fine dust. The dust was extracted with 1,000 times as much weight of PBS containing 0.05% Tween 20 for 2 h with constant rotation. After low-speed centrifugation, the supernatant was used as a dust sample.

Quantitation of Mite Allergens

The major mite allergens (*Der p* I, *Der f* I and *Der* II) were measured by a radioimmunoassay described previously [10]. Briefly,

glass rods coupled with F(ab')₂ fragment of antibodies to each allergen were added to a sample in a tube and incubated overnight at room temperature. The glass rods were washed and then incubated with antibody to each allergen for 3 h. After washing, ¹²⁵I-labeled protein A was added to the glass rods. After incubation for 3 h, the glass rods were washed. Radioactivity bound was then quantitated in a gamma counter.

Results

Airborne and Floor Dust Allergens in the Living Room

Table 1 shows the levels of aeroallergens and floor dust allergens in the living room. The airborne allergen levels of *Der* I were very low, ranging from 7.6 to 116.0 pg/m³ (geometric mean, 29.5 pg/m³). Those of *Der* II were also very low, ranging from 1.7 to 35.1 pg/m³ (geometric mean, 6.3 pg/m³). The allergen levels of *Der* I and *Der* II in the floor dust were 2,040 and 2,690 ng/g fine dust, respectively. There was no significant correlation between airborne and floor dust allergen levels in each home. The aeroallergen level of *Der* I was higher than that of *Der* II (*Der* I: *Der* II = 4.7:1), while the floor allergen of *Der* I had the same level as that of *Der* II (*Der* I: *Der* II = 0.8:1). Comparing the amounts of *Der f* I and *Der p* I, we noticed that *D. pteronyssinus* was dominant in these apartments.

Table 2. Airborne and quilt dust allergens in the bedroom (disturbed condition)

Home	Aeroallergens, pg/m ³					Dust allergens, ng/g fine dust				
	<i>Der p</i> I	<i>Der f</i> I	<i>Der I</i> ^a	<i>Der II</i>	I/II ^b	<i>Der p</i> I	<i>Der f</i> I	<i>Der I</i> ^a	<i>Der II</i>	I/II ^b
A	19,700	1,050	20,700	11,100	1.9	47,000	4,110	51,100	45,500	1.1
B	23,400	1,430	24,800	9,560	2.6	22,600	977	23,600	21,700	1.1
C	253,000	11,600	265,000	180,000	1.5	16,100	763	16,900	17,600	1.0
D	105,000	150	105,000	11,400	9.2	57,300	393	57,700	44,600	1.3
E	6,040	5,210	11,300	3,900	2.9	8,900	18,600	27,500	18,600	1.5
F	47,800	2,230	50,000	22,100	2.3	88,100	1,080	89,200	74,000	1.2
G	24,700	< 63	24,700	10,900	2.3	46,000	604	46,600	43,200	1.1
H	7,380	525	7,900	4,050	2.0	15,400	5,830	21,200	17,600	1.2
I	27,300	1,140	28,400	16,400	1.7	67,800	4,690	72,500	67,000	1.1
J	5,810	12,400	18,200	7,630	2.4	415	13,500	13,900	5,030	2.8
Geometric mean			30,900	12,600	2.5			35,500	28,200	1.3

^a *Der p* I and *Der f* I add up to *Der I*.

^b Ratio of *Der I* to *Der II*.

Airborne Allergens in the Disturbed Condition in the Bedroom

Table 2 shows the aeroallergen levels in the disturbed condition as well as the allergen levels in the quilt dust. The airborne levels of *Der I* in the disturbed condition were very high, ranging from 7,900 to 265,000 pg/m³ (geometric mean, 30,900 pg/m³). Those of *Der II* were also high, ranging from 3,900 to 180,000 pg/m³ (geometric mean, 12,600 pg/m³). The allergens of *Der I* and *Der II* in the quilt dust were 35,500 and 28,200 ng/g of fine dust, respectively, which are more than 10 times those of *Der I* and *Der II* in the floor dust. There was no significant correlation between the airborne and quilt dust allergen levels. The ratio of *Der I* to *Der II* in the air in the disturbed condition (*Der I*:*Der II* = 2.5:1) was higher than that in the quilt dust (*Der I*:*Der II* = 1.3:1).

Discussion

In this study, we measured the content of both *Der I* and *Der II* in the air and in samples of the floor or quilt dust. The aeroallergen level of *Der I* was higher than that of *Der II* in the living room, whereas the amounts of *Der I* in the floor dust were at the same level as those of *Der II*. Similar findings were observed in the disturbed condition. This suggests that *Der I*

might be more prone to float in the air than *Der II*; probably, *Der I* which are derived from mite feces might become smaller particles than *Der II*, derived from mite bodies.

There was no significant correlation between airborne and floor or quilt dust allergen levels. This result is understandable, since the allergen levels per gram of fine dust do not necessarily represent the absolute amounts of allergens present on the floor or quilt. Further, the human activity in a room, which makes the allergens float in the air, varies in each home.

In this study, we were able to measure airborne mite allergen levels in the living room when usual domestic life is continued. So far, it has been difficult to measure the airborne major mite allergens, because conventional air samplers are too noisy to be operated for a long time in the house and the airborne major allergen levels under ordinary life conditions are too low to be detected. In this investigation, we found that the levels of *Der I* were very low, 7.6–116 pg/m³, though a large amount of mite allergens were present on the floor. On the contrary, the aeroallergen level increased about 1,000-fold in the disturbed condition (bedmaking); they were strongly influenced by the human activity. Similarly, Swanson et al. [11] reported that the concentration of airborne crude mite allergens increased greatly in a bedroom during bedmak-

ing. Further, we found that dust samples obtained from the quilt had more mite allergens per weight of fine dust than those obtained from the floor.

We could point out the following precautions against exposure to mite aeroallergens. Children should keep out the bedroom during bedmaking. For asthma patients, the used quilts should be washed with hot water [7], or renewed.

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