

Original article

Distribution of house dust mite allergen: comparing house dust mite allergen levels in dust samples collected from different sites on living room floors with smooth coverings

Background: The distribution of house dust mite allergen (Der p1) in living rooms with smooth floor coverings, as measured in the middle compared with the border of the floor was investigated. It was hypothesized that activity causes displacement of Der p1, from the middle towards the border.

Methods: Dust samples from the middle and border of 50 floors with smooth coverings were collected and analysed on Der p1 content in a standardized way.

Results: The Der p1 exposure expressed as per unit area (ng/m^2) showed that border samples contained significantly more Der p1 compared with middle samples (median: 2.57 vs 0.27, respectively, $P = 0.023$). Presence of pets and presence of more than two inhabitants increased the difference. When expressed as per unit weight of dust (ng/g), significant differences were only detected when comparing Der p1 content of samples collected in households with three or more inhabitants [median: 2 (border) vs 53 (middle), respectively; $P = 0.035$].

Conclusions: The Der p1 is unequally distributed on living room floors with smooth coverings, most likely because of displacement of dust from the middle towards the border due to activity. Expression as ng/g of dust and ng/m^2 could not obviously be interchangeable.

**T. Maas, J. J. M. Rovers,
H. J. A. M. Schönberger,
C. P. van Schayck**

Department of General Practice, Maastricht University, The Netherlands

Key words: allergen; dermatophagoides; der p1; distribution; floor covering; house dust; mite; pteronyssinus.

T. Maas, MSc
Department of General Practice
Maastricht University
P.O. Box 616
6200 MD Maastricht
The Netherlands
Tel.: +31 43 388 23 24
Fax: +31 43 361 93 44

Accepted for publication 17 January 2003

In most survey studies concerning measurement of exposure to house dust mite allergen (Der p1) in floor dust, the sampling procedure is standardized (1, 2). For measurement within living rooms, the recommendation was made that at least two sites should be sampled because of unequal distribution (3). However there is no uniformity about the exact sampling locations (4). The aim of the present study was to investigate whether Der p1 content of floor dust samples collected from sites at the border compared with sites in the middle of living rooms with smooth floor coverings are comparable. We hypothesized that activity causes displacement of dust and Der p1 mainly from the middle towards the border.

Methods

Dust samples were collected from 50 living room floors with smooth coverings. Participants were asked to make sure that 1 week prior to sampling, rugs if present were removed and their living room floor was not cleaned. Presence of pets in the living room and number of inhabitants were assessed. On each floor two dust samples were collected of which one was at the border (3 m^2 adjacent to the wall, 1 m wide) and another as much as possible in the middle of the room (3 m^2). It was made sure that the sampling sites were as far as possible from frequently

used doors. Sampling sites were vacuumed for $2 \text{ min}/\text{m}^2$ each (vacuum cleaner 1300 W). Dust was collected onto glass microfibre filters and stored at -12°C until analysis. After weighing the unsieved dust, a 10% (w/v) extract in borate-buffered saline with 0.1% Tween-20, pH 8.0, was obtained by overhead rotation for 2 h at room temperature. After centrifuging (10 min 4250 RPM), Der p1 content was determined by means of two-site monoclonal ELISA with an assay sensitivity of $2 \text{ ng}/\text{g}$ of dust. Allergen standard 93/03 ($2500 \text{ ng}/\text{ml}$ Der p1) was used for calculation of results. Data were expressed as ng/g of dust and Der p1 content expressed as ng/m^2 was computed.

Untransformed Der p1 levels were used for statistical analysis, as logarithmic transformation failed to normalize the distribution. By means of the nonparametric Wilcoxon signed ranks test ($\alpha = 0.05$) comparison was made between Der p1 levels of the two sampling sites.

Results

In Tables 1 and 2, median, range and level of significance of Der p1 content of middle vs border samples are presented. Table 1 contains data expressed as ng/m^2 and data expressed as ng/g of dust are shown in Table 2. Data on overall allergen content and on the comparison of samples collected in homes with vs those without pets and, with less than three vs those with three or more inhabitants are presented.

Table 1. Comparison of Der p1 content of dust samples collected from sites in the middle and at the border of living room floors with smooth coverings expressed as per unit area (ng/m^2)

	<i>n</i>	Median (range)		<i>P</i> ($\alpha = 0.05$)
		Middle	Border	
Overall data	50	0.27 (0.0067–84.89)	2.57 (0.0067–161.60)	0.023
More than two inhabitants				
Yes	23	0.29 (0.053–84.84)	4.58 (0.053–83.50)	0.018
No	27	0.25 (0.0067–84.89)	0.39 (0.0067–161.60)	0.501
Presence of pets				
Yes	19	0.29 (0.053–84.89)	5.76 (0.093–161.60)	0.009
No	31	0.25 (0.0067–84.84)	0.37 (0.0067–83.50)	0.465

Table 2. Comparison of Der p1 content of dust samples collected from sites in the middle and at the border of living room floors with smooth coverings expressed as per unit weight of dust (ng/g)

	<i>n</i>	Median (range)		<i>P</i> ($\alpha = 0.05$)
		Middle	Border	
Overall data	50	2 (2–749)	21 (2–835)	0.136
More than two inhabitants				
Yes	23	2 (2–471)	53 (2–835)	0.035
No	27	2 (2–749)	2 (2–606)	0.955
Presence of pets				
Yes	19	2 (2–749)	53 (2–606)	0.124
No	31	2 (2–471)	2 (2–835)	0.687

Overall more Der p1 was found in samples collected at the border compared with levels in the middle of the room irrespective of the way of expression (ng/g or ng/m^2). However, when expressed as ng/g of dust, the difference appeared not to be significant ($P = 0.136$) in contrast to the expression as ng/m^2 .

The median overall Der p1 content, expressed as ng/m^2 , in middle samples vs samples at the border were 0.27 and 2.57, respectively ($P = 0.023$).

In households where pets were allowed to stay in the living room ($n = 19$) and in those that were occupied by more than two inhabitants ($n = 23$), the difference of Der p1 content showed to be larger than the difference in overall Der p1 content, again irrespective of the way of expression. A significant difference between the median Der p1 content in samples collected at the border as compared with the middle of the room in households with three or more inhabitants was demonstrated when expressed as ng/m^2 and ng/g dust ($P = 0.018$ and $P = 0.035$, respectively). As was the case when comparing middle and border samples on overall Der p1 content, presence of pets showed to differ significantly only when data were expressed as ng/m^2 (ng/m^2 $P = 0.009$, ng/g $P = 0.124$).

Discussion

The results of the present study show that on smooth floor coverings there actually does seem to be a clear pattern of distribution of Der p1, for we found significantly greater amounts of Der p1 at the border compared with areas in the middle of the living room floor. Earlier research on the distribution of Der p1 within carpeted living rooms did not show a consistent pattern of distribution of Der p1, although a great variation of Der p1 levels between areas on the floor was found (5).

Although factors affecting the distribution of house dust mites (6) are unclear, our findings suggest that on floors with smooth coverings, activity favours displacement of Der p1 towards the border. As was hypothesized, Der p1 levels in the middle of the room showed to be less than at the border and distribution is increased when more inhabitants or pets are present.

It is of further interest whether allergen content of dust should be expressed as ng/m^2 or as ng/g of dust. In epidemiological studies, expression as ng/g of dust is considered to be suitable, however in intervention studies expression as ng/m^2 is recommended (2). In addition, the suggestion has been made that these methods for expression can be interchanged (7). In the present study, however, this was not the case, as variation of the amount of dust (g) between different sampling areas on the living room floor lead to different results when Der p1 content was expressed as ng/g of dust. Where a statistically significant difference was detected between middle and border samples when expressed as ng/m^2 , no significant difference was detected when overall data were expressed as ng/g of dust. Possibly the lack of significance can be explained by the smaller range of Der p1 results when expressed as ng/g of dust. However, the expression as ng/m^2 does reflect the actual amount of Der p1 present at the sampled area whereas the expression as ng/g of dust merely reflects the concentration of Der p1 in floor dust.

We conclude that Der p1 content of dust samples taken from middle and border sites on the living room floor differ significantly when expressed as ng/m^2 , most likely the result of displacement of dust from the middle towards the border because of activity by inhabitants and pets. When expressed as ng/g of dust, a statistically significant difference was determined only when comparing data on Der p1 content in samples collected in households with three or more inhabitants. We suggest that Der p1 content expressed as ng/g of dust and ng/m^2 cannot obviously be interchanged. Given this knowledge and the plausibility that Der p1 expressed as ng/m^2 does reflect the actual allergen exposure, our study results do underline the use of the expression as ng/m^2 in studies in which Der p1 exposure is a possible determining factor.

References

1. PLATTS-MILLS TAE, THOMAS W, AALBERSE RC, VERVOLET D, CHAPMAN MD. Dust mite allergens and asthma: Report of a second international workshop. *J Allergy Clin Immunol* 1992;**89**:1046–1060.
2. LUCZYNSKA CM. Identification and quantification of mite allergens. *Allergy* 1998;**53**(Suppl 48):54–57.
3. MARKS GB, TOVEY ER, PEAT JK, SALOME CM, WOOLCOCK AJ. Variability and repeatability of house dust mite allergen measurement: implications for study design and interpretation. *Clin Exp Allergy* 1995;**25**:1190–1197.
4. HILL MR. Quantification of house dust mite populations. *Allergy* 1998;**53**(Suppl 48):18–23.
5. SIMPSON A, HASSALL R, CUSTOVIC A, WOODCOCK A. Variability of house-dust-mite allergen levels within carpets. *Allergy* 1998;**53**:602–607.
6. COLLOFF MJ. Practical and theoretical aspects of the ecology of house dust mites (Acari: Pyroglyphidae) in relation to the study of mite-mediated allergy. *Rev Med Vet Entomol* 1991;**79**:611–629.
7. CUSTOVIC A, TAGGART SCO, McL NIVEN R, WOODCOCK A. Evaluating exposure to mite allergens. *J Allergy Clin Immunol* 1995;**96**:134–135.