

Indoor mite allergens in patients with respiratory allergy living in Porto, Portugal

Plácido JL, Cuesta C, Delgado L, Moreira da Silva JP, Miranda M, Ventas P, Vaz M. Indoor mite allergens in patients with respiratory allergy living in Porto, Portugal.
Allergy 1996; 51: 633-639. © Munksgaard 1996.

We investigated the levels of mite allergens (Der p 1, Der f 1, Der 2, and Lep d 1) in dust samples from the homes of 59 patients with asthma, 36 sensitized to house-dust mites (HDM) and 23 to grass pollen (controls), living in Porto, northern Portugal. The relationship between exposure and sensitization to HDM and the influence of housing conditions on mite-allergen levels were also evaluated. Der p 1 (median 9.2 µg/g) and Der 2 (4.6 µg/g) were the main allergens, while Der f 1 and Lep d 1 levels were always <1 µg/g dust and undetectable in 11% and 47% of samples, respectively. All HDM-sensitized asthmatics were exposed to Der p 1 levels >2 µg/g and their homes contained significantly higher levels of Der p 1 (median 12.5 vs 6.4 µg/g; $P=0.008$) and Der 2 (6.2 vs 3.0 µg/g; $P=0.004$) when compared to the control group. A significant correlation was observed between the exposure to Der p 1 and the wheal area at skin testing with the *Dermatophagoides pteronyssinus* (Dp) extract ($P=0.01$) as well as with serum specific IgE levels to Dp ($P=0.03$). Patients with higher levels of serum specific IgE (≥ 17.5 HRU/ml) were also more frequently exposed to Der p 1 levels ≥ 10 µg/g ($P=0.002$). Old homes, presence of carpets, and signs of dampness were conditions associated with significantly higher levels of mite allergens. In conclusion, we found high levels of Der p 1 and Der 2 particularly in the homes of HDM-sensitized patients and we confirm the relationship between exposure and sensitization to HDM, assessed by both *in vivo* and *in vitro* methods. In addition to a favorable outdoor climate, we found in our region housing conditions propitious to mite growth, suggesting that specific geographic characteristics must also be taken into account for the correct planning of mite-avoidance measures.

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Key words: house-dust mites; housing conditions; indoor allergens; sensitization.

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Accepted for publication 11 April 1996

Mites of the *Dermatophagoides* genus are the main source of house-dust allergens and their contribution to allergic diseases, particularly asthma, has been recognized worldwide as a major health problem (1). Considerable epidemiologic evidence supports an association between the levels of exposure to HDM allergens and the risk of sensitization in genetically predisposed persons, and of acute asthma in sensitized patients (2). Moreover, an increased frequency of allergic diseases has been reported (3) and related to a higher exposure to indoor allergens, as the result of a change in lifestyle and housing conditions (4). These points

focused the attention of numerous investigators on the exposure to these allergens in different geographic areas and the question of which environmental factors determine mite growth (5-12).

The present study aimed to quantify the levels of mite allergens (Der p 1, Der f 1, Der 2, and Lep d 1) in dust samples from the homes of 59 asthmatic patients (36 with HDM allergy and 23 controls sensitized to grass pollen) living in Porto, northern Portugal. We also studied the relationship between exposure to mite allergens and sensitization to HDM, as well as the influence of housing conditions on mite allergen levels.

Material and methods

Patients

Thirty-six patients, 19 females and 17 males aged 7–58 years (median 21 years), were consecutively selected from our outpatient clinic by documented history of perennial asthma and positive skin prick tests (wheal area ≥ 7 mm², determined by planimetry) only to HDM (*Dermatophagoides pteronyssinus* [Dp] and/or *D. farinae* [Df]) with or without concomitant sensitization to *Lepidoglyphus destructor* (Ld).

We used standardized mite extracts with an activity of 100 BU/ml, which is the concentration eliciting a geometric mean wheal area of 75 mm² (13), included in a battery of 20 other common inhalant allergens (animal dander, grass and tree pollen, molds – Alergia e Imunologia Abelló SA).

We also studied 23 controls with seasonal asthma, 13 females and 10 males, aged 12–57 years (median 31 years), exclusively sensitized to grass pollen.

All patients from the mite and control group had serum specific IgE levels ≥ 0.70 HRU/ml (Hamlet®, Alergia e Imunologia Abelló, SA) (14) to mites or grass pollen, respectively (equivalent to RAST greater than or equal to class 2).

The patients included in this study lived in Porto, a city of 500 000 inhabitants in northern Portugal on the Atlantic coast. The weather is temperate and humid, with a mean annual temperature of 14 °C, high pluviometric rates (1200 mm/year), and a mean annual relative humidity of 78% (data relative to 1992 and obtained from the meteorological observatory in Porto).

Questionnaire

Patients were asked to answer a questionnaire on socioeconomic status and housing conditions. Variables recorded were educational level; monthly income; age of the home; whether private or apartment buildings; home location on first or upper floor; number of bedrooms and occupants; type of floor cover (carpets, wooden floor, rugs); frequency of vacuum cleaning; presence of central heating, air conditioner, or dehumidifiers; signs of dampness (visible wet spots and mold growth on the walls); and presence of pets.

Collection of dust samples and allergen determination

Samples were collected from the bedroom and living room by the patients, using their own vacuum cleaner provided with a new disposable paper bag.

All the 59 dust samples were collected in April 1992. Patients were advised not to vacuum-clean their homes for a week before the collection of samples, and no avoidance measures were proposed before sampling. The mattress, the floor around and under the bed, carpets, rugs, and the upholstered furniture were vacuumed for 2 min/m². Each disposable paper bag was hermetically sealed in a zippered plastic bag and stored at 4°C until processing.

Dust samples were sieved through a 300-µm-diameter screen. An amount of 3 g sieved dust was extracted in 20 ml phosphate-buffered saline (15%, w/v), with magnetic stirring for 90 min at 4°C. The mixture was centrifuged at 12 000 rpm for 5 min, and the supernatant filtered through 0.45-µm filters (Milipore Flow Rate, Flow Laboratories, Germany). The extracts were stored at –20°C until analyzed.

Der p 1, Der f 1, and Lep d 1 were quantified with specific monoclonal antibodies-based solid-phase ELISA (15, 16). Der 2 was determined by the method of Heymann et al. (17). Allergen levels were expressed in µg/g of dust and were classified as undetectable if under 0.05 µg/g, according to the proposed score by Platts-Mills et al. for the *Dermatophagoides* group 1 allergens (18), which was extended to the other allergens.

Statistical analysis

Allergen levels were expressed as the median and range. Differences between patient groups were analyzed with the Mann-Whitney test. Correlation analyses were made with Spearman's rank correlation, and the chi-square test was used for 2×2 contingency tables. For all comparisons, statistical significance was considered to be present if $P < 0.05$.

Results

In our study, none of the mite-allergic patients had an isolated cutaneous sensitization to Df or Ld, while 89% (32/36) were sensitized to both Dp and Df, and 67% (24/36) had positive skin prick tests to Ld.

Der p 1 and Der 2 were detected in all dust samples (Table 1) and were the main mite allergens. The median level of Der p 1 in the 59 homes was 9.2 µg/g (range: 0.1–119.0 µg/g); of Der 2, it was 4.6 µg/g (range: 0.3–61.0 µg/g). The highest detected concentration of these two allergens, 119 µg/g of Der p 1 and 61 µg/g of Der 2, was found in the old damp home of a mite-allergic patient, with carpets in the bedroom and living room.

The concentrations of Der f 1 and Lep d 1 were undetectable, respectively, in 11% and 47% of the

Table 1. Percentage of dust samples from homes of patients with allergy to house-dust mites (HDM) and to grass pollen (controls - C) with undetectable (<0.05), low (0.05–2.00), moderate (2.00–10.00), and very high (>10.00 µg/g dust) levels of Der p 1, Der f 1, Der 2, and Lep d 1.

	Der p 1		Der f 1		Der 2		Lep d 1	
µg/g	HDM	C	HDM	C	HDM	C	HDM	C
<0.05	0	0	8	13	0	0	42	52
0.05–2.00	0	26	92	87	14	26	58	48
2.01–10.00	47	48	0	0	53	65	0	0
>10.00	53	26	0	0	33	9	0	0

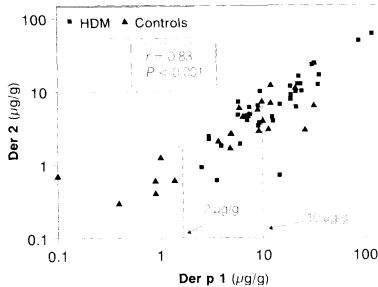


Fig. 1. Der p 1 and Der 2 levels in mite-allergic patients ($n = 36$) and controls ($n = 32$). All patients sensitized to house-dust mites (HDM) were exposed to Der p 1 levels above 2 µg/g dust in comparison to 74% of controls ($\chi^2 = 10$, $P = 0.005$). Levels above 10 µg/g were found in 53% of patients with mite allergy and in 26% of controls ($\chi^2 = 4.1$, $P = 0.04$). Significant correlation was also observed between these two allergens ($r = 0.83$, $P < 0.001$).

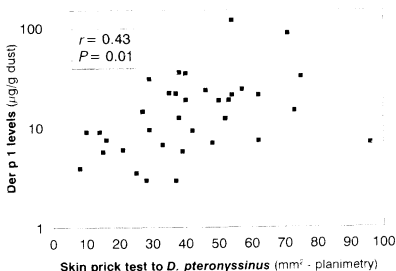


Fig. 2. In patients sensitized to HDM, significant correlation ($r = 0.43$, $P = 0.01$) was observed between levels of Der p 1 in dust samples and wheal area (mm²) obtained at skin prick testing with extract of *D. pteronyssinus* (100 BU/ml).

59 dust samples (Table 1) and were always under 1 µg/g of dust: Der f 1 ($n = 59$; 0.13 µg/g; <0.05–

0.85 µg/g) and Lep d 1 (0.09 µg/g; <0.05–1.00 µg/g).

We observed a significant correlation between the levels of the three major *Dermatophagoides* allergens: Der p 1/Der 2 ($n = 59$; $r_s = 0.83$, $P < 0.001$) (Fig. 1), Der p 1/Der f 1 ($r_s = 0.33$, $P = 0.04$), and Der 2/Der f 1 ($r_s = 0.30$, $P = 0.04$).

All mite-atopic patients were exposed to Der p 1 levels above 2 µg/g, a level which is regarded as a risk of sensitization (2), in comparison with 74% of controls ($\chi^2 = 10$, $P = 0.005$). The exposure to levels above 10 µg/g, which has been proposed as a threshold value for the development of acute asthma in sensitized patients (2), was found in 53% of mite-allergic patients, in comparison with 26% from the control group ($\chi^2 = 4.1$, $P = 0.04$) (Fig. 1).

The homes of mite-allergic patients contained significantly higher concentrations of Der p 1 (12.5 µg/g; 2.5–119.0 µg/g in comparison with 6.4 µg/g; 0.1–31.9 µg/g; $P = 0.008$) and Der 2 (6.2 µg/g; 0.6–61.0 µg/g in comparison with 3.0 µg/g; 0.3–12.4 µg/g; $P = 0.004$) than those of patients sensitized to grass pollen.

Both groups were exposed to similar levels of Der f 1 (0.13 µg/g; <0.05–0.38 µg/g; in comparison with 0.12 µg/g; <0.05–0.85 µg/g; $P = \text{NS}$), while Lep d 1 tended to be higher in the homes of mite-atopic patients (0.10 µg/g; <0.05–1.00 µg/g in comparison with 0.06 µg/g; <0.05–1.00 µg/g; $P = \text{NS}$).

In patients with HDM allergy, a significant correlation was observed between the levels of Der p 1 in house dust and the wheal area obtained at skin testing with the extract of Dp ($n = 36$; $r_s = 0.43$, $P = 0.01$) (Fig. 2), as well as with the serum specific IgE levels ($r_s = 0.37$, $P = 0.03$). Moreover, 83% of patients with Dp serum specific IgE > 17.5 HRU/ml (equivalent to RAST of class 4) were exposed to Der p 1 levels above 10 µg/g, while 88% of patients exposed to levels under these suggested threshold values had RAST less than class 4 ($\chi^2 = 10$, $P = 0.002$). The Der p 1 levels were also statistically different ($P = 0.005$) between the group of patients with RAST of class 4 (21.2 µg/g; 9.3–119.0) and those with RAST of class 2 or 3 (9.0 µg/g; 2.5–34.9) (Fig. 3).

The two groups were comparable in age, socio-economic status, and housing conditions, and there was no association between the concentration of mite allergens and educational level or socio-economic status. The relationship between mite-allergen levels and each of the home characteristics was analyzed, but only a few (old homes, signs of dampness, and presence of carpets in the bedroom and/or living room) were associated with significantly higher levels of Der p 1 and Der 2 in both groups of patients (Table 2). Other characteristics, such as homes on the first floor, private buildings,

Table 2. Relation between housing conditions and mite-allergen levels (Der p 1 and Der 2), expressed as $\mu\text{g/g}$ of dust, in homes of patients sensitized to house-dust mites (HDM) and grass pollen (controls). Old homes, presence of carpets, and signs of dampness were conditions associated with significantly higher levels of these allergens (* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$).

Housing characteristics	Patients sensitized to HDM (n=36)			Control group (n=23)		
	No. of homes	Der p 1	Der 2	No. of homes	Der p 1	Der 2
Old homes (>20 years)	17	14.5 (2.9–119.0) ^{†*}	8.5 (0.7–61.0) ^{†*}	10	9.4 (3.7–32.0) ^{†*}	3.3 (1.1–7.4)
New homes (<20 years)	19	6.4 (2.5–23.6) ^{†*}	2.5 (0.6–27.1) ^{†*}	13	4.5 (0.1–26.0) ^{†*}	1.3 (0.3–12.4)
Private buildings	10	9.3 (3.0–88.0)	6.6 (0.7–49.0)	9	8.5 (4.9–22.4)	4.0 (0.6–12.4)
Apartment buildings	26	8.7 (2.5–119.0)	6.2 (0.6–61.0)	14	6.2 (0.1–32.0)	2.9 (0.3–7.4)
First floor	12	14.7 (3.9–88.0)	7.5 (0.7–49.0)	8	9.6 (1.0–26.0)	3.0 (0.6–12.4)
Upper floor	24	12.0 (2.5–119.0)	5.4 (0.6–61.0)	15	4.9 (0.1–32.0)	2.6 (0.3–7.4)
More than two rooms	10	5.1 (2.5–88.0)	4.1 (0.6–61.0)	6	5.2 (0.1–32.0)	2.2 (0.3–10.3)
One or two rooms	26	5.3 (3.1–119.0)	4.4 (0.8–45.0)	17	4.6 (0.4–22.4)	2.4 (0.4–12.4)
More than four occupants	15	9.2 (2.5–88.0)	5.7 (0.9–45.0)	9	4.6 (0.1–9.9)	2.7 (0.3–7.4)
Four or fewer occupants	21	7.0 (3.1–119.0)	6.0 (0.6–61.0)	14	7.2 (1.0–32.0)	4.0 (0.6–12.4)
Carpets	15	22.3 (5.8–119.0) ^{†**}	11.8 (1.9–61.0) ^{†**}	13	10.0 (4.9–32.0) ^{†***}	4.0 (0.6–12.4) ^{†**}
No carpets	21	9.0 (2.5–35.0) ^{†*}	3.7 (0.6–12.7) ^{†*}	10	2.9 (0.1–9.9) ^{†*}	1.1 (0.3–7.4) ^{†*}
Signs of dampness	22	20.0 (3.5–119.0) ^{†**}	5.9 (0.6–61.0) ^{†**}	11	11.3 (4.9–32.0) ^{†**}	4.0 (0.6–12.4) ^{†*}
No signs of dampness	14	7.2 (2.5–22.0) ^{†*}	3.0 (0.7–31.0) ^{†*}	23	3.5 (0.1–9.9) ^{†*}	1.5 (0.3–7.4) ^{†*}

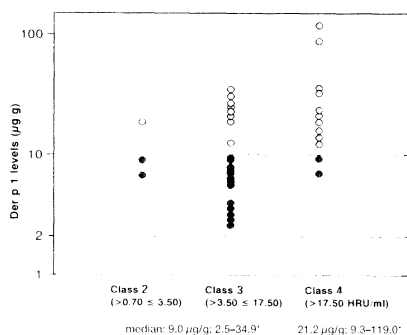


Fig. 3. Patients with higher levels of *D. pteronyssinus* serum specific IgE (>17.5 HRU/ml, equivalent to RAST of class 4) were more often exposed to Der p 1 levels above 10 $\mu\text{g/g}$ dust, while patients with serum specific IgE <17.5 HRU/ml (class 2/3) were more often exposed to Der p 1 levels under this threshold value ($\chi^2 = 10$, $P = 0.002$). Patients with RAST of class 4 were also exposed to significantly higher Der p 1 levels than those with RAST of class 2/3 (* $P = 0.005$).

and higher number of occupants and rooms, tended to be associated with higher levels of these two allergens, but the associations were not statistically significant. For each studied characteristic, the homes from mite-allergic patients invariably contained higher concentrations of Der p 1 and Der 2. No significant association was found between hous-

ing conditions and the concentrations of the other two mite allergens, Der f 1 and Lep d 1. Some housing conditions were uncommon in our population: only one of the 59 homes had central heating and another one had air conditioning. Dehumidifiers were never observed, and the frequency of vacuum-cleaning was once a week in all houses. Pets (cats or dogs) were present in only five houses, two belonging to mite-allergic patients and three to patients sensitized to grass pollen.

Discussion

High concentrations of Der p 1 and Der 2 were found in the homes of both HDM-sensitized and nonsensitized patients. These levels are much higher than those found in some regions of Australia (19), the USA (20), Scandinavia (9, 12), The Netherlands (11), and Canada (6) and comparable to those previously reported in other parts of the world such as some geographic areas in Spain (21, 22), France (23), and Thailand (24). Studies conducted in the UK (10), Brazil (5), and, more recently, in Sydney, Australia (25) have found higher levels of HDM allergens than in Porto. However, in our study, the samples were collected in spring (April), and it is possible that the concentrations of these allergens are higher in the rainy seasons of autumn and winter.

Der f 1 was undetectable in 11% of the dust samples, and it was always present under the level of 1 $\mu\text{g/g}$ of dust, while the cutaneous sensitization to Df was invariably associated with Dp. Porto's

temperate and humid climate could explain this predominance of Dp over Df in contrast to other countries where the long, dry winters may favor the growth of Df (26).

As a potential source of indoor allergens, storage mites have received particular attention in recent years (27). Among patients living in damp housing conditions (28) and in wet tropical countries (29), this sensitization can be particularly important. In our study, the 24 patients with positive skin prick tests to Ld were invariably sensitized to the other two mites. Lep d 1 was detected in 44% of the dust samples, but it was always present in very low concentrations ($<1 \mu\text{g/g}$ of dust) in spite of the high outdoor humidity and numerous homes with signs of dampness. These results confirm the concomitant sensitization to these two families of dust mites (27) and suggest that Ld is a minor mite in Porto's urban environment.

Patients sensitized to HDM were all exposed to Der p 1 levels above $2 \mu\text{g/g}$, confirming this value as a reasonable threshold concentration for sensitization (2), while 53% were exposed to concentrations of Der p 1 above $10 \mu\text{g/g}$ of dust, representing an important risk of acute asthma (2). These two threshold values were present in a significantly small number of patients sensitized to grass pollen. These results agree with those of other studies (12, 30, 31), suggesting that higher levels of mite allergens are more frequently present in the homes of patients sensitized to HDM than in the homes of patients without such sensitization.

We found a significant correlation between exposure to Der p 1 and the wheal area obtained at skin testing with Dp extract (Fig. 2) and also with Dp serum specific IgE levels. Moreover, patients with high levels of serum specific IgE (class 4) were more often exposed to Der p 1 levels above $10 \mu\text{g/g}$ ($\chi^2=10$; $P=0.002$) and to significantly higher levels of this allergen ($21.2 \mu\text{g/g}$; 9.3–119.0 in comparison with $9.0 \mu\text{g/g}$; 2.5–34.9; $P=0.005$) than patients with RAST of class 2 or 3 (Fig. 3). Our results support the recognized association between exposure to HDM and sensitization when evaluated by both *in vivo* and *in vitro* methods (10, 31–34). However, in a recent paper, Marks et al. (25) were unable to confirm this association in a population of Sydney schoolchildren exposed to extremely high levels of mite allergen. They compared the Der p 1 levels in patients with or without HDM allergy, as defined by skin prick tests (SPT), but included in their HDM-nonallergic group both atopic and nonatopic patients who had distinct genetic predisposition to IgE sensitization. Moreover, in our study, we related the Der p 1 concentrations not only to SPT positivity but also to the degree of IgE

sensitization to HDM (wheal area determined by planimetry and serum specific IgE levels).

Studies of the relationship between exposure to HDM allergens and environmental factors, which are highly dependent on the geographic area, are critical in planning the best mite-avoidance measures for allergic patients and represent one of the current fields of interest.

In Porto, the outdoor humidity is high without significant variations throughout the year (range: 68–88%) with a mild outdoor temperature (range: 6–35°C), conditions that favor the growth of mites and the presence of high allergen levels. The use of air-control appliances and the presence of unventilated homes are uncommon in Porto. In contrast to Scandinavian homes where HDM can be eradicated by increased ventilation to keep indoor humidity low (35), this procedure would probably be ineffective in Porto because of high outdoor humidity (36, 37).

Confirming previous observations of other authors, we found significantly higher levels of Der p 1 and Der 2 in older homes (6, 11, 38), those with signs of dampness (7–9, 11, 12, 38), and those with carpets in the bedroom and/or living room (11). In addition to the favorable outdoor climate, we found a significant number of homes with propitious conditions for mite growth, particularly the homes of mite-allergic patients: 47% were old houses, 61% had signs of dampness, and 42% were carpeted.

Homes with a higher number of occupants, those located on the first floor, and private buildings tended to have a higher concentration of these two allergens although with no statistically significant differences. These conditions have also been found to be associated with significantly higher concentrations of mite allergens (6, 11, 34). In our study, the reduced number of homes with pets, in contrast to other countries (39), and the fact that the frequency of vacuum-cleaning was the same in all homes, did not allow the investigation of the influence of these two factors in mite-allergen levels. We did not find any significant association between the housing characteristics and the levels of Der f 1 and Lep d 1, but it is possible that the low levels of these two allergens may explain the failure to detect the influence of housing conditions.

In conclusion, high levels of Der p 1 and Der 2 were present in house-dust samples, particularly those from homes of patients sensitized to house-dust mites who were exposed to significantly higher levels of these two allergens. In our environment, we confirmed the predominance of *D. pteronyssinus* over *D. farinae*, and that *L. destructor* is a minor dust mite. The exposure to Der p 1 was also correlated with sensitization, assessed by both *in*

vivo and *in vitro* methods. In addition to a favorable outdoor climate, we found in our region a significant number of homes with propitious conditions for mite growth, particularly those of mite-allergic patients, reinforcing the importance of specific mite-avoidance measures. Furthermore, specific geographic characteristics related to home and climatic conditions must also be taken into account in the correct planning of these measures.

References

- World Health Organization. Dust mite allergens and asthma: a worldwide problem. International Workshop Report. Bull World Health Organ 1988;66:769-80.
- Platts-Mills TAE, Thomas WR, Aalberse RC, Vervloet D, Chapman MD. Dust mite allergens and asthma: report of a second international workshop. J Allergy Clin Immunol 1992;89:1046-60.
- Peat JK. The rising trend in allergic illness: which environmental factors are important? Clin Exp Allergy 1994; 24:797-800.
- Platts-Mills TAE, Sporik RB, Chapman MD, Heyman PW. The role of indoor allergens in asthma. Allergy 1995;50 Suppl 22:5-22.
- Arruda LK, Rizzo MC, Chapman MD, et al. Exposure and sensitization to dust mite allergens among asthmatic children in São Paulo, Brazil. Clin Exp Allergy 1991;21:433-9.
- Chan-Yeung M, Becker A, Lam J, et al. House-dust mite allergen levels in two cities in Canada: effects of season, humidity, city and home characteristics. Clin Exp Allergy 1995;25:240-6.
- Dotterrud LK, Korsgaard J, Falk ES. House-dust mite content in mattresses in relation to residential characteristics and symptoms in atopic and nonatopic children living in northern Norway. Allergy 1995;50:788-93.
- Kuehr J, Frischer T, Karmaus W, et al. Natural variation in mite antigen density in house dust and relationship to residential factors. Clin Exp Allergy 1994;24:229-37.
- Munir AKM, Björkstén B, Einarsson R, et al. Mite allergens in relation to home conditions and sensitization of asthmatic children from three climatic regions. Allergy 1995;50:55-64.
- Sporik R, Holgate S, Platts-Mills TAE, Cogswell JJ. Exposure to house-dust mite allergen (*Der p 1*) and the development of asthma in childhood. N Engl J Med 1990; 323:502-7.
- van Strien RI, Verhoeff AP, Brunekreef B, van Wijnen JH. Mite antigen in house dust: relationship with different housing conditions in The Netherlands. Clin Exp Allergy 1994;24:843-53.
- Wickman M, Nordvall SL, Pershagen G, Sundell G, Schwartz B. House-dust mite sensitization in children and residential characteristics in a temperate region. J Allergy Clin Immunol 1991;88:89-95.
- Lombardero M, Gonzalez R, Duffort O, et al. Evaluación de la actividad biológica total y composición alérgica de extractos alérgenos. Allergol Immunopathol (Madr) 1986;14:189-98.
- Sánchez-Madrid F, Morago G, Corbi AL, Carreira J. Monoclonal antibodies to three distinct epitopes on human IgE: their use for determination of allergic specific IgE. J Immunol Methods 1984;73:367-78.
- Ventas P, Lombardero M, Duffort O, Carreira J. Cuantificación de los alérgenos *Der p 1* and *Der f 1* de los ácaros del polvo doméstico y *Fel d 1* de gato mediante un ELISA en fase sólida. Rev Esp Alergol Inmunol Clin 1990;5:71-5.
- Ventas P, Carreira J, Polo F. Cuantificación del alérgeno mayoritario de *L. destructor* (*Lep d 1*) mediante anticorpos monoclonales. Rev Esp Alergol Inmunol Clin 1990;5 Suppl 3:88.
- Heymann PW, Chapman MD, Aalberse RC, Fox JW, Platts-Mills TAE. Antigenic and structural analysis of group II allergens (*Der f 1* and *Der p 1*) from house dust mites (*Dermatophagoides* spp.). J Allergy Clin Immunol 1989;83: 1055-67.
- Platts-Mills TAE, Hayden ML, Chapman MD, Wilkins SR. Seasonal variation in dust mite and grass-pollen allergens in dust from the houses of patients with asthma. J Allergy Clin Immunol 1987;79:781-91.
- Collot MJ, Stewart GA, Thompson PJ. House dust acarofauna and *Der p 1* equivalent in Australia: the relative importance of *Dermatophagoides pteronyssinus* and *Euroglyphus maynei*. Clin Exp Allergy 1991;21:225-30.
- Lintner TJ, Brame K. The effects of season, climate, and air-conditioning on the prevalence of *Dermatophagoides* mite allergens in household dust. J Allergy Clin Immunol 1993;91:862-7.
- Barber D, Chamorro MJ, Carpizo JA, et al. Valoración de la presión alérgica ambiental. Interés de esta determinación en la prevención, diagnóstico y tratamiento de las enfermedades alérgicas. Rev Esp Alergol Inmunol Clin 1990;5:125-32.
- Echechipia S, Ventas P, Audicana M, et al. Quantitation of major allergens in dust samples from urban populations collected in different seasons in two climatic areas of the Basque region (Spain). Allergy 1995;50:478-82.
- Pauli G, Quoix E, Hedelin G, Bessot JC, Ott M, Dietemann A. Mite allergen content in mattress dust of *Dermatophagoides*-allergic asthmatics/rhinitis and matched controls. Clin Exp Allergy 1993;23:606-11.
- Malainual N, Vichayanond P, Phan-Urai P. House dust mite fauna in Thailand. Clin Exp Allergy 1995;25:554-60.
- Marks GB, Tovey ER, Toelle BG, Wachinger S, Peat JK, Woolcock AJ. Mite allergen (*Der p 1*) concentration in houses and its relation to the presence and severity of asthma in a population of Sydney schoolchildren. J Allergy Clin Immunol 1995;96:441-8.
- Platts-Mills TAE, Chapman MD. Dust mites: allergic disease, and environmental control. J Allergy Clin Immunol 1987;80:755-75.
- Spieksma FthM. Domestic mites: their role in respiratory allergy. Clin Exp Allergy 1991;21:655-60.
- Iverson M, Dahl R. Allergy to storage mites in asthmatic patients and its relation to damp house conditions. Allergy 1990;45:81-5.
- Fernandez-Caldas E, Mercado P, Puerta L, Lockey RE, Caraballo LR. House dust mite sensitivity and mite fauna in the tropics. J Allergy Clin Immunol 1992;89:257.
- Lau S, Falkenhörst G, Weber A, et al. High mite-allergen exposure increases the risk of sensitization in atopic children and young adults. J Allergy Clin Immunol 1989;84:718-25.
- Verhoeff AP, van Strien RI, van Wijnen JH, Brunekreef B. House dust mite allergen (*Der p 1*) and respiratory symptoms in children: a case-control-study. Clin Exp Allergy 1994;24:1061-9.
- Kuehr J, Frischer T, Meinert R, et al. Mite allergen exposure is a risk for the incidence of specific sensitization. J Allergy Clin Immunol 1994;94:44-52.
- De Lovinfosse S, Charpin D, Dornelas A, Birnbaum J, Vervloet D. Can mite-specific IgE be used as a surrogate for mite exposure? Allergy 1994;49:64-6.

34. Wickman M, Nordvall SL, Pershagen G, Korsgaard J, Johansen N. Sensitization to domestic mites in a cold temperate region. *Am Rev Respir Dis* 1993;148: 58-62.
35. Wickman M, Emenius G, Egmar A-C, Axelsson G, Pershagen G. Reduced mite allergen levels in dwellings with mechanical exhaust and supply ventilation. *Clin Exp Allergy* 1994;24:109-14.
36. Colloff MJ. Dust mite control and mechanical ventilation: when the climate is right. *Clin Exp Allergy* 1994;24:94-6.
37. Dornelas Andrade A, Birnbaum J, Lantecume A, et al. Housing and house-dust mites. *Allergy* 1995;50:142-6.
38. Hart BJ, Whitehead L. Ecology of house dust mites in Oxfordshire. *Clin Exp Allergy* 1990;20:203-9.
39. Mata P, Charpin D, Vervloet D. Allergy to pets. *Aerobiologia* 1990;6:87-92.

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