

Effect of house dust mite avoidance measures in children with atopic dermatitis

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Summary

Background House dust mite allergens are associated with atopic dermatitis (AD).

Objectives The aim of our study was to verify if house dust mite allergen avoidance measures can improve the clinical manifestations of AD in children.

Methods Forty-one children (mean age 3.9 years) affected by AD associated with high total and/or specific IgE serum levels ('extrinsic' AD) were recruited. Clinical evaluation was performed utilizing the Severity Scoring of AD (SCORAD) index; dust was sampled from the children's beds and tested using an enzyme-linked immunosorbent assay. The study was planned in two parts. In the first part, a placebo-controlled trial of 2 months duration, mite allergen avoidance measures (encasing mattresses and pillows; a weekly hot wash of bedding; frequent vacuum cleaning of living room and bedroom; soft toys and carpets regularly cleaned or removed; no pets allowed) were recommended to group A patients, but not to group B. In the second part of the study, environmental avoidance measures were recommended to initial control group B patients also. One year after the start of the study the amounts of mite allergen in the home and clinical score of AD were measured in both groups.

Results At the end of the first part of the study, significant decreases in major allergens of *Dermatophagoides pteronyssinus* (Der p1) and *D. farinae* (Der f1) load (from 393 to 94 ng m⁻²) and concentration (from 1.84 to 0.73 µg g⁻¹ of dust) in children's beds were observed in treatment group A. At the same time, in this group the mean SCORAD index improved significantly (from 33 to 26; *P* = 0.022). After 12 months, when all patients had used allergen avoidance measures, Der p1 + Der f1 load, concentration and clinical score had improved, reaching similar values in both groups.

Conclusions Simple mite allergen avoidance measures should be recommended to families with children affected by extrinsic AD in order to control the clinical manifestations and prevent mite sensitization.

Key words: atopic dermatitis, *Dermatophagoides farinae*, *Dermatophagoides pteronyssinus*, house dust mite avoidance

Atopic dermatitis (AD) is a frequent chronic skin disease that begins early in childhood and affects about 10% of children.¹ The clinical features are likely to result from multifactorial inheritance, with an interaction between genetic and environmental factors. AD is associated with allergen-specific IgE antibodies in up to 80% of cases² and this variant of AD is usually called 'extrinsic'. It differs from the 'intrinsic' variant

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that is not associated with elevated IgE antibodies² even though it shares the same clinical features. Food allergy may be a trigger factor of AD especially in the first years of life.³ It has, however, been shown that food sensitivity in children frequently improves in the first years of life,⁴ after which the role of environmental allergens seems to become more important in the maintenance of AD symptoms, above all house dust mites (HDMs), which are the major indoor

environmental allergens. In a previous study on children with AD, a correlation between HDM concentrations and specific IgE against mites was observed.⁵

Several studies have evaluated the influence of the dust mite on clinical symptoms in AD.^{6–8} A marked clinical improvement of AD was observed by Tan *et al.*⁹ in a group of adults and children with positive skin tests (not necessarily towards mites), after an intensive eradication programme for mite allergens. The authors found that the greatest benefit from HDM avoidance seemed to occur in children.⁹ There have been many attempts to eradicate HDMs in the home by using bedding encasement, acaricides and preparations that denature antigens.¹⁰ The use of encasing has been reported to be the most effective means of reducing the levels of HDM antigens,¹¹ as well as being the most easily applied.¹²

The aim of our study was to continue the observations of our previous investigation⁵ to evaluate the clinical effect of dust avoidance by bedding encasement, and to correlate these data with the amount and concentration of HDMs and with the course of AD in the study group of children.

Subjects and methods

This study is a continuation of the investigation reported in our paper published in the *British Journal of Dermatology*.⁵ The same 41 children (20 boys and 21 girls) previously reported were enrolled for the new study. They were aged 2–10 years (15 children aged 24–48 months; 10 aged 49–60 months; nine aged 61–72 months and seven aged 73–120 months; mean age 3.9 years) and the diagnosis of AD had been made by satisfying the criteria of Hanifin and Rajka.¹ At the start of the study, no patient had any atopic respiratory symptoms. The clinical evaluation of AD was performed by the same operator utilizing the Severity Scoring of AD (SCORAD) index.¹³

Allergometric assessment and house dust mite collection and determination

Data regarding allergy assessment and HDM collection were extensively reported in our previous paper.⁵ In brief, all patients had the extrinsic variant of AD, i.e. raised serum total IgE antibodies and/or the presence of specific IgE antibodies to foods or inhalant allergens.

The dust was collected in the period October–November 1997 from the children's beds, by the

same two operators with a specific dust-collection device (ALK-Laboratories, Hørsholm, Denmark) as described by Dreborg *et al.*¹⁴ The collecting device was a suction mouthpiece that is constructed for mounting on common European vacuum cleaners. The air was sucked through a cellulose filter (ALK-Laboratories) with pores of a size that did not allow the relevant particles to pass through the filter. The ALK filter retains about 75% of particles 0.3–0.5 µm in size, 80% of particles 0.5–1 µm in size, 95% of particles 1–10 µm in size, and 100% of larger particles. The mattress of each child's bed was vacuumed on the upper surface for 2 min m⁻². The samples collected were weighed on an electric balance and stored at –18 °C until extraction. In each sample we determined the dust load (mg m⁻²) and the concentration of major allergens of *Dermatophagoides pteronyssinus* (*Der p1*) and *D. farinae* (*Der f1*) in the dust, expressed both as ng m⁻² and as µg g⁻¹ of dust.

The HDM level was tested by an enzyme-linked immunosorbent assay (ELISA) (ALK-Laboratories). Ready-to-use microwell plates were precoated with antibodies against *Der p1* allergen. The extracted dust samples and the standards were incubated for 2 h with the immobilized antibodies. The microwell plates were read on an automated photometer at 490 nm. A standard curve was plotted and the sample concentrations of major allergens were calculated. The allergen levels were expressed as µg g⁻¹ of dust. The detection limit of the ELISA was 0.1 µg g⁻¹ of dust. The summed values for *Der p1* and *Der f1*, assayed separately, were considered to be the level of mite exposure.

Study plan

The present study was planned in two parts. First, a controlled trial of 2 months duration was performed, as it was clearly demonstrated by Tan *et al.*⁹ that a significant reduction of HDMs can be obtained after such a period. The patients were randomly divided into two groups in order of presentation: group A (21 children) and group B (20 children). HDM avoidance measures were recommended to group A patients, but not to the patients in group B.

HDM avoidance measures consisted of encasing mattresses and pillows with mite microfine fibres or the Goretex[®] bedding system; a hot weekly wash of bedding; living room and bedroom vacuum cleaned at least twice a week; soft toys washed once a week or excluded from the bedrooms; carpets removed or vacuum cleaned once a week or more. No pets were

Table 1. Change in dust load and dust allergen concentration during 1 years of study. Mean and 95% confidence interval

	Dust load (mg m ⁻²)				Allergen concentrations (Der p1 + Der f1, ng m ⁻²)				Allergen concentrations (Der p1 + Der f1, µg g ⁻¹ of dust)			
	T0	T1	T2	T12	T0	T1	T2	T12	T0	T1	T2	T12
Group A	214 (169–269)	199 (144–275)	98 (56–169)	138 (40–275)	393 (194–779)	230 (112–371)	94 (49–195)	87 (44–173)	1.84 (1.17–3.15)	1.17 (0.68–1.99)	0.73 (0.3–1.4)	0.59 (0.29–1.1)
Group B	371 (257–537)	204 (141–295)	209 (158–275)	126 (83–190)	731 (288–1819)	299 (125–724)	306 (114–794)	105 (40–275)	2.04 (0.95–4.3)	1.46 (0.45–2.5)	1.40 (0.29–2.1)	0.74 (0.35–1.6)

In the first 2 months, active mite avoidance measures were recommended only to group A. After the second month, avoidance measures were also recommended to group B. T0, baseline; T1, first month; T2, second month; T12, twelfth month. Group A: dust load T0 vs. T2 $P = 0.014$; T0 vs. T12 $P = 0.05$; T1 vs. T2 $P = 0.018$; allergen concentrations (ng m⁻²) T0 vs. T1 $P = 0.039$; T1 vs. T2 $P = 0.025$; allergen concentrations (µg g⁻¹ of dust) T0 vs. T1 $P = 0.05$; T1 vs. T2 $P = 0.027$. Group B: dust load T0 vs. T1 $P = 0.004$; T2 vs. T12 $P = 0.016$; allergen concentrations (ng m⁻²) T0 vs. T1 $P = 0.001$; T2 vs. T12 $P = 0.008$; allergen concentrations (µg g⁻¹ of dust) T2 vs. T12 $P = 0.044$.

allowed. The group B patients did not undertake any specific HDM avoidance measures and continued to clean their houses as before the start of the study. Advice on HDM avoidance measures was given by one of us, an individual who was not subsequently involved in evaluating the clinical score of patients or in dust collection, but who did check on compliance with HDM avoidance measures. The two investigators responsible for collecting dust were not informed about this controlled blind study: one of them sampled the dust in the beds of group A patients, and the other one in the group B patients. We did not think that the use of two different investigators would introduce any bias in our study as the collecting method was very simple and standardized and before the start of the study the investigators had obtained similar results in

preliminary tests. In any case, the aim of our study was the comparison between different values in HDMS within each group and not between the two groups. During this phase of the study, clinical evaluation was made every month by the same investigator in a blinded fashion. We considered this to be the best way of ensuring blinding.

In the second part of the study, we recommended environmental avoidance measures to the previous control group B patients also, and 1 year after the beginning of the study (i.e. during October–November 1998) we evaluated the clinical severity of AD and the amounts and concentrations of HDMS in the home in both group A and group B patients. Topical steroids and oral antihistamines were allowed only in the case of an acute relapse of AD. During both phases of the study, the two groups did not undertake dietary restriction or receive systemic steroid treatment.

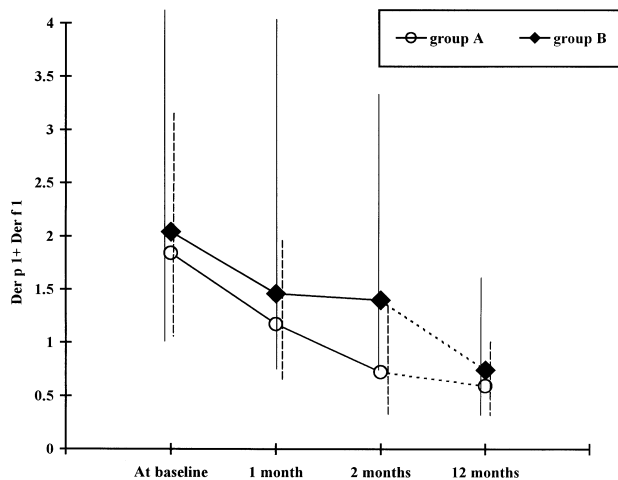


Figure 1. Mattress concentration of Der p1 + Der f1 (µg g⁻¹ of dust) in active mite avoidance group (group A) and in control group (group B). After the second month mite avoidance measures were recommended also to group B. Vertical lines indicate 95% confidence interval: group A (○), dotted lines; group B (◆), solid lines. Group A: baseline vs. 1 month $P = 0.05$; baseline vs. 2 months $P = 0.027$; group B: 2 months vs. 12 months $P = 0.044$.

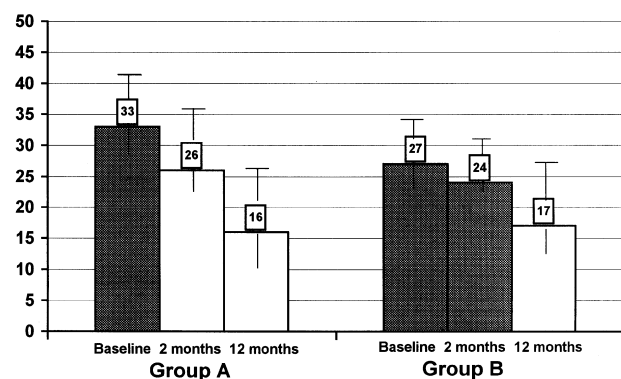


Figure 2. Effect of house dust mite (HDM) avoidance on eczema severity (Severity Scoring of Atopic Dermatitis mean value and 95% confidence interval) in group A (active avoidance group) and group B (control group). After the second month of study avoidance measures were also recommended to group B. Stippled bars, no HDM avoidance; open bars, HDM avoidance. Group A: baseline vs. 2 months $P = 0.022$; 2 months vs. 12 months $P = 0.01$; group B: 2 months vs. 12 months $P = 0.05$.

Statistics and ethical consideration

Statistical analysis used the Statistical Package for Social Science (SPSS/PC). The distribution of dust weights was normalized by logarithmic transformation, and Student's *t*-test was used for comparison in the different phases of the treatment. *Der p1* + *Der f1* concentrations were not normalized by logarithmic transformation, and non-parametric analysis (Fisher's exact test) was used for comparison. Informed consent was obtained from the parents before the children were included in the study.

Results

Comparison of mite-avoidance and control groups

The first part of the study consisted of a trial between the active mite avoidance (group A) and the control (group B) groups. A considerable decrease in HDM load in children's beds was observed in group A during the first and the second study months. The geometric mean of dust load at the beginning of the study was 214 mg m⁻²; after the first month it was 199 mg m⁻², and after the second month it was 98 mg m⁻², with significant differences vs. the baseline value (*P* = 0.014) and also vs. the first month value (*P* = 0.018).

In group A, the initial geometric mean of *Der p1* + *Der f1* amount in the children's beds was 393 ng m⁻²; this amount decreased significantly after the first month (230 ng m⁻²; *P* = 0.039) and the second month (94 ng m⁻²; *P* = 0.025) (Table 1).

Der p1 + *Der f1* concentration expressed as µg g⁻¹ of dust showed a similar trend: the baseline geometric mean (1.84 µg g⁻¹ of dust) decreased significantly (*P* = 0.05) after the first month (1.17 µg g⁻¹ of dust) and after the second month (0.73 µg g⁻¹ of dust; *P* = 0.027) (Fig. 1).

In group A, the baseline mean clinical score (SCORAD index) was 33; 1 month later we found a statistically significant (*P* = 0.011) decrease in eczema severity (SCORAD = 24). Although further improvement was not observed after the second month (SCORAD = 26), the mean clinical score at this point was significantly lower than at the beginning of the study (*P* = 0.022; Fig. 2). The percentage of SCORAD improvement was 27% at the end of the first month and 21% after 2 months.

In the control group (group B) the initial geometric mean of dust load was 371 mg m⁻²; the *Der p1* + *Der f1* amount was 731 ng m⁻² and *Der p1* + *Der f1*

concentration was 2.04 µg g⁻¹ of dust. After 1 month, we found a significant reduction in the dust load (204 mg m⁻²; *P* = 0.004) and of *Der p1* + *Der f1* amount (299 ng m⁻²; *P* = 0.001; Table 1), but the concentration expressed as µg g⁻¹ of dust showed a small but not significant reduction (Fig. 1). None of these three parameters had changed after 2 months (Table 1; Fig. 1). In this group we observed, at the first month, a slight but not significant clinical improvement (decrease in SCORAD from 27 to 22) followed by a slight worsening of the mean clinical score at the second month (SCORAD = 24; Fig. 2). The percentage of improvement in the SCORAD index from the baseline was 18% at the end of the first month and 11% after 2 months.

Follow-up of house dust mite avoidance measures

In the second phase of the study, HDM avoidance measures were recommended to all patients. After 12 months, at the end of the study, we observed a significant (*P* = 0.016) reduction of the dust load in group B (126 mg m⁻²), which reached a similar value to that of group A. In group A we found a slight increase of dust load (138 mg m⁻²), although this value was always significantly (*P* = 0.05) lower than the baseline.

The amount of *Der p1* + *Der f1* decreased both in group A (87 ng m⁻²) and in group B (105 ng m⁻²) but significantly (*P* = 0.008) only in group B (Table 1). At the end of the study both groups showed a significant reduction of *Der p1* + *Der f1* concentration expressed as µg g⁻¹ of dust: the final geometric mean concentration in group A was 0.59 µg g⁻¹ of dust and in group B was 0.74 µg g⁻¹ of dust (*P* = 0.044; Fig. 1).

At the same time the clinical score (SCORAD index) showed a significant improvement both in group A (*P* = 0.01) and in group B (*P* = 0.05). The last mean SCORAD was 16 for group A and 17 for group B (Fig. 2). The percentage of improvement in the SCORAD index from the start was 52% in group A and 37% in group B after 12 months.

Discussion

In an interesting double-blind placebo-controlled study, Tan *et al.*⁹ observed significant benefits in a group of patients, predominantly adults, with AD who embarked on intensive dust avoidance measures (mattress encasing, high-filtration vacuum cleaning, use of acaricide

and allergen-denaturing spray). Following this observation, and as AD is most prevalent in the first years of life, we analysed the effects of dust avoidance in a group of children. We enrolled patients significantly younger than those in the previous study, but excluded children younger than 2 years to avoid the risk of food allergy interference. The patients were randomly assigned to an active mite avoidance group or to a control group at the beginning of the study. No significant differences in clinical severity or *Der p1* + *Der f1* concentration (as $\mu\text{g g}^{-1}$ of dust) were observed between the two groups at the start of the study, while, by chance, dust load (mg m^{-2}) and consequently the allergen concentration (ng m^{-2}) were significantly different.⁹ However, the aim of our analysis was to observe the changes within the group and we therefore do not believe this difference to be relevant.

In the initial active mite avoidance group we observed an improvement in clinical score values even by the end of the first month; these stabilized after the second month, and further improvements occurred after 12 months.

The significant decrease in dust load (from 371 to 204 mg m^{-2}) and concentration (from 731 to 299 ng m^{-2}) observed in the control group after the first month was particularly striking, even if a similar effect was observed by Tan *et al.*⁹ It is possible that our presence in the home of the patients to collect mite samples may have been a trigger to improve HDM clearance. This hypothesis is partially confirmed by the observation that dust load (from 204 to 209 mg m^{-2}) and concentration (from 299 to 306 ng m^{-2}) values between the first and the second month were virtually unchanged in the control group, while in the mite avoidance group the concentrations were significantly lower at the second month (from 199 to 98 mg m^{-2} and from 230 to 94 ng m^{-2}) compared with the first month.

We were aware that the avoidance measures proposed in this study were not particularly stringent, in that we chose to suggest only environmental measures with bedding encasing without the use of acaricides and allergen denaturants. There is still no agreement in the literature about the use of acaricides and allergen denaturants, and their real efficacy, and some authors believe that they only have a limited role in controlling mite allergens.¹⁵ On the other hand, the effectiveness of controlling mite allergens in beds by using bedding encasement with mite-blocking fibre is now well established.^{11,15} Another consideration influenced our choice of such avoidance measures:

we wanted to suggest realistic measures that could be applied for a long period, even years, without our continuous supervision. We think that the slow decrease in HDM load may be related to the adoption of environmental avoidance measures alone. The data on HDM loads after 12 months, which show a decreased and similar value in both groups, support our initial approach. The decrease in *Der p1* + *Der f1* load from the initial values of 1.84 and 2.04 $\mu\text{g g}^{-1}$ of dust to the final values of 0.59 and 0.74 $\mu\text{g g}^{-1}$ of dust is similar to that reported by Nishioka *et al.*¹¹ in Japan, after 1 year of avoidance measures.

The clinical improvement observed in the initial active mite avoidance group, even by the first month of the study, may be related to the initial decrease in HDM concentration: a small HDM reduction is probably sufficient to reduce skin hypersensitivity in patients with AD. In our opinion the most important parameter substantially changed by HDM avoidance measures, which could have brought about the clinical improvement in our patients, was the *Der p1* + *Der f1* concentration ($\mu\text{g g}^{-1}$ of dust). This parameter is also the one most frequently related to clinical improvement in asthma or other allergic respiratory diseases and also to mite sensitization.¹⁵

This significant improvement over a brief period (1–2 months) occurred during the autumn and winter season, and was probably not associated with a spontaneous remission of disease, as AD is usually exacerbated during these seasons.² On the other hand, we cannot exclude the possibility that the observed clinical improvement after 12 months of follow-up was partially linked to the spontaneous remission of AD in these children.

In our previous study we detected HDM sensitization related to HDM concentrations in children with AD,⁵ in accordance with the results of other authors.¹¹ This sensitization may have already occurred by the first years of life,¹⁶ especially in children with associated food sensitization.^{17,18}

HDM avoidance measures should be suggested to all families with children suffering from extrinsic AD, even in the first months of life, in order to control the cutaneous manifestations of AD, and to prevent HDM sensitization. HDM sensitization in children with AD is the most important predictive factor for the appearance of allergic respiratory disease, above all asthma.^{19–21}

Our data show that by using simple but efficacious environmental measures, a significant reduction in HDM in bedding takes place after 2 months. When avoidance measures are well explained, parents

observing the improvement of AD in their children are motivated to maintain such prevention for longer periods, as shown by the low HDM level observed at 12 months in both groups. Future studies in patients with intrinsic AD may indicate whether HDM avoidance measures may also lead to an improvement in this variant.

Acknowledgments

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