Accumulation of house-dust mite (Der-p-1) levels on mattress covers

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Mattresses serve as a large reservoir for house-dust mite antigens and harbour the highest mite levels within the household. Mite reduction measures have previously been shown to be unsuccessful. The effect of mattress covers and acaracides on Der-p-1 levels in the mattresses of 60 patients with mite-allergic asthma was studied. Der-p-1 levels were measured using monoclonal antibodies (ELISA method). Baseline levels were recorded and re-assessed at 8-week intervals over a 6-month period. Patients were randomised into three equal groups. In group A mattresses were treated with Metsan (Snowchem) and benzylbenzoate only; group C had their mattresses covered with mattress covers (Allergy Control Products). Group B was the control group.

We were unable to demonstrate any reduction of mite levels in the beds of all 3 groups. In fact all 3 groups demonstrated an increase in Der-p-1 levels over the study period, viz. group A (mean pre: 14,28, post: 34,18 µg/g dust); group C (mean pre: 8,26, post: 20,80 µg/g dust) and group B (mean pre: 18,21, post 38,47 µg/g dust). However, 12 patients in group C had their mattress covers washed in hot water at weekly intervals over a 5-week period at the end of the study. The results demonstrated a significant reduction in mite levels (mean pre: 41,95, post: 26,2 µg/g dust; $P = 0,027$).

We therefore conclude that the use of mattress covers *per se* does not reduce Der-p-1 levels. The regular application of benzylbenzoate and Metsan does not prevent the accumulation of Der-p-1 on mattresses either. Hot water washing of mattress covers, if possible, will reduce Der-p-1 levels and must be performed regularly.

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Inhalent allergens play a major role in the pathogenesis of asthma and allergic rhinitis in children and the house-dust mites, *Dermatophagoides pteronyssinus* (Der-p-1) and *Dermatophagoides farinae* (Der-f-1), are the predominant inhalent allergens in most South African coastal cities.[1] Since the level of exposure to Der-p-1 antigen has been directly related to the severity of symptoms, it is important to attempt to reduce the level of Der-p-1 and Der-f-1 antigens in the bedrooms of mite-allergic patients.[2]

The efficacy of house-dust mite avoidance measures using acaricides such as tannic acid and benzylbenzoate has been well documented in clinical studies of patients who have moved to mite-free environments. These patients have demonstrated both an improvement of asthma and a decrease in bronchial hyperreactivity.[3,4] Mattress covers have long been advised in the management of house-dust allergy, but these encasings vary in type, and few studies of their effectiveness have been undertaken.[5,6] Our previous study[7] showed that a single application of benzylbenzoate significantly reduced Der-p-1 levels in bedroom carpets in the Cape Town area, but had no effect on Der-p-1 levels on mattresses. In this study, we investigated the ability of a commercial mattress cover (Allergy Control Products, Ridgefield, USA) and repeated applications of benzylbenzoate and a tannic acid solution to reduce Der-p-1 levels on mattress surfaces of asthmatic children.

Material and methods

Sixty children aged 6 - 14 years, with mild to moderate asthma and allergy to Der-p-1 (on skin-prick testing or RASTS) but negative to other aero-allergens, were included in this study. Patients were randomised into 3 groups (A, B, C) by means of a system of random numbers. Patients were studied for 6 months and their homes were visited by the same investigator, who collected the dust samples from mattresses and carpets and applied the acaricide treatment.

At the beginning of the study, 'baseline' bronchial hyperreactivity was determined in each child by means of a histamine challenge test, and baseline dust samples were collected from the mattresses and carpets of the child's bedroom. Dust samples were collected 4 times at 8-weekly intervals. At the end of the study all patients underwent a repeat histamine challenge test. The 3 patient groups, each comprising 20 patients, were studied as follows.

Group A

This group had Metsan (Snowchem) with benzylbenzoate applied to both the carpets and the mattresses. The active ingredient of Metsan is bromopol, a detergent. A combination of Metsan and benzylbenzoate was prepared for this study. After the first dust sampling it was applied to the carpets and mattresses. The carpets were vacuumed 24 hours later to remove the residue. This procedure was repeated every 8 weeks until the end of the study.

Group B

This was the control group. Dust samples were collected at 8-weekly intervals from the mattresses and carpets but no acaricides were applied to the bedding or the carpets. No mattress covers were used in this group.

Group C

This was the second test group. After baseline samples were collected, their mattresses and pillows were encased in mattress and pillow covers. These are zippered cotton mattress covers that are laminated on the inner surface. They are impermeable to particulate matter but permeable to water vapour. They are therefore more comfortable than previously recommended plastic covers. Three per cent tannic acid was applied to the carpets. In the subsequent 8-weekly visits we repeated dust sampling, taking samples from the surface of the mattresses. The 3% tannic acid solution was sprayed on the carpets at 8-week intervals. The 3% tannic acid solution was also supplied by Allergy Control Products. Mattress covers were not washed during the study period.

Der-p-1 determination

Dust samples were obtained with a Vorwerk vacuum cleaner with a disposable bag. This was done according to a standardised protocol[7] which included vacuuming 1 m^2 of the carpet for 2 minutes and 2 m^2 of the mattress for 2 minutes. Each dust bag was sealed and the samples stored at –20°C. Der-p-1 levels were quantitated by means of an ELISA technique with monoclonal antibodies obtained from Dr M. Chapman (University of Virginia, Charlottesville, USA).

Bronchial hyperreactivity

This was assessed by means of the histamine challenge test described by Yan *et al.*[8] This test was carried out at the beginning of the study and repeated at the end of the study. Children discontinued antihistamines and anti-inflammatory inhalant for at least 48 hours and bronchodilators for 24 hours prior to the test. Patients on steroids were not studied. Cromoglycate was discontinued 24 hours before the challenge.

Effect of washing mattress covers in hot water

At the end of the 24-week study period, the effect of washing of mattress covers in hot water was investigated in 12 homes. These covers came from patients in group C who had the highest levels of Der-p-1. Mattress covers were washed once weekly for 5 consecutive weeks in hot soapy water at > 70°C for 30 minutes. Following this, Der-p-1 levels were determined in dust samples obtained from the surface of mattresses at the end of 5 weeks.

In order to exclude a possible seasonal variation in the levels of house-dust mites during the study period, dust samples were taken monthly from March to November from the carpets and mattress surfaces of 4 patients in the control group. Mite antigen levels were determined by means of the Der-p-1 ELISA.

Results

Der-p-1 levels on mattresses

Mean baseline Der-p-1 levels ranged from 8,3 µg/g dust in group A to 19,2 µg/g dust in group C (Fig. 1). All 3 groups showed a significant increase in dust levels at the second sampling. The levels fell marginally in the 16-week and 24-week samples. Der-p-1 levels were extremely high on the mattress surfaces in all 3 groups (A: 34,2 µg/g dust; B: 38,5 µg/g dust; C: 20,9 µg/g dust) at the end of the study. There was no statistically significant difference between the levels obtained in the 3 groups at each sampling time point.

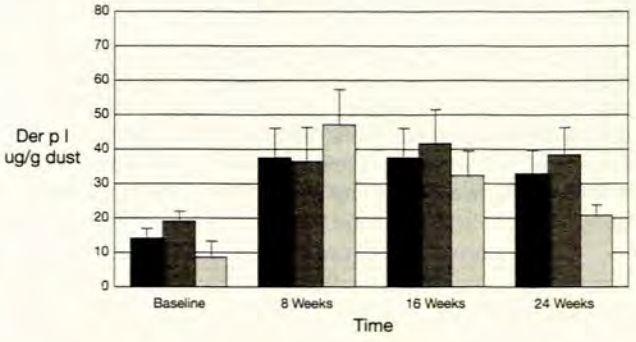

Fig. 1. Mean Der-p-1 levels on mattresses (µg/g dust ± SEM) (group A ■; control group B ■ ; group C (mattress covers) □.

Der-p-1 levels on carpets

Mean baseline Der-p-1 levels were 7,5, 13,1 and 4,8 µg/g dust for groups A, B and C respectively (Fig. 2). Subsequent samplings from carpets in groups A and B did not show a significant change in the levels. By contrast group C showed a sharp rise at the second sampling and the carpet levels in group C remained higher than in the other 2 groups for the remainder of the study.

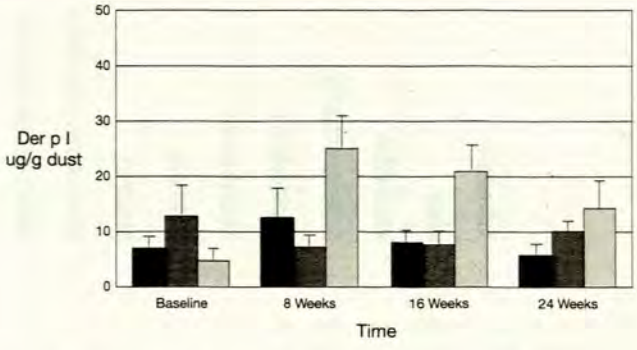

Fig. 2. Mean Der-p-1 levels on floors (µg/g dust ± SEM) (group A ■; control group B ■ ; group C (mattress covers) □.

Effect on bronchial hyperreactivity

Differences between the mean bronchial hyper-responsiveness (PC_{20}) levels at the beginning and at the end of the study were determined. Paired *t*-tests were used to compare the mean differences in the 3 groups. The mean difference for group A was 1,257, for group B, 0,134 and for group C, 1,206. No significant change in the PC_{20} was found in any of the groups.

Effect of washing of mattress covers in hot water

The mean levels of Der-p-1 antigen on the 12 mattress covers at the end of the 24-week study period prior to washing was 41,95 µg/g dust and, after 5 weeks of regular washing, 26,2 µg/g dust ($P = 0,027$).

Seasonal variation of house-dust mite levels

Arithmetic and geometric mean levels in carpets and mattress covers in the 4 control homes over the 10-month period studied are shown in Figs 3 and 4 respectively. In both groups peak levels were observed in November and December, but very high levels were also observed on the mattresses between May and August, the wettest months in Cape Town.

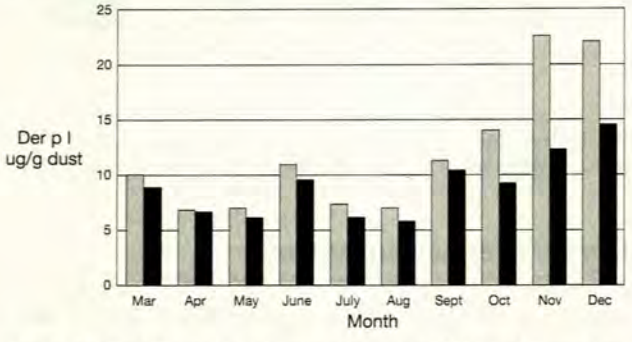

Fig. 3. Seasonal variation of arithmetic mean (☐) and geometric mean (■) Der-p-1 levels on carpets (µg/g dust).

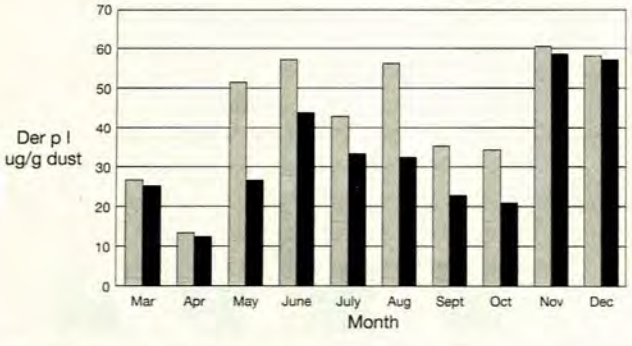

Fig. 4. Seasonal variation of arithmetic mean (☐) and geometric mean (■) Der-p-1 levels on mattress covers (µg/g dust).

Discussion

This study has shown that covering the mattresses of Cape Town asthmatic children with a commercial mattress cover resulted in a significant accumulation of mites in the 24-week period studied. The study was conducted during the winter months when the proliferation of house-dust mites is known to increase because of increased indoor humidity. We also found that the application of benzylbenzoate and Metsan to the mattresses in group A did not prevent the accumulation of Der-p-1 antigens. Also the application of a benzylbenzoate-Metsan combination or 3% tannic acid to the carpets was totally ineffective in achieving a reduction in mite antigen levels. These findings clearly show the resistance of house-dust mite to conventional control measures.

There are several possible explanations for the ineffectiveness of mattress covers in our patients. In the first instance, house-dust mite levels are known to be high in our area. In areas where mite levels are high, there is a large reservoir of live mites which continue to proliferate on bedroom furnishings, bedding and carpets. As these become airborne during normal activities in the room, they will settle onto the bedding and ultimately onto the mattress or mattress covers. Thus, unless there is elaborate reduction in the pool of mites from other sources in the room, these mites will soon find their way to the ideal environment of the mattress surfaces.

The mean baseline Der-p-1 levels on mattresses were very high, and since no improvement in mite levels was achieved, the absence of any improvement in the PC_{20} of the patients was expected. A closer look at our results shows that the Der-p-1 accumulation in the beds of patients with mattress covers in the first 4 weeks after application of the covers initially exceeded the Der-p-1 accumulation in the control group (Fig. 1). It is likely that blankets and duvets also carry a significant pool of live mites which then deposit on the mattress surfaces. In the past, scant attention has been given to eradication of mites from this obvious source (e.g. by hot washing (> 70°C)). There was a dramatic increase in mite levels on carpets from 4,8 µg/g to 25,4 µg/g in group B in the first 8 weeks of the study. It is likely that these mites came from the patients' bedding or mattress covers when the beds were made up.

Our study suggests that covering of mattresses makes absolutely no difference to mite-sensitive patients if mattress covers are not also frequently washed in hot water. Although we have also shown that regular hot water washing of mattress covers known to be colonised with mites will result in a significant reduction of these mites, the reduction achieved did not approach acceptable levels (less than 1,0 µg/g dust). It would therefore seem necessary to treat other potential sources of mites such as blankets and duvets before mattress covers are introduced.

The seasonal variation of mites in 4 patients from the control group over a 10-month period confirmed high levels of Der-p-1 antigen on mattresses and carpets throughout this period. The highest levels were observed in November and December. Our main study was conducted between April and October.

As far as can be determined, only one other study has investigated the efficacy of mattress covers manufactured by Allergy Control Products.[6] This study demonstrated a significant clinical improvement in the encasing regimen group after 8 months. The manufacturers only recommend 6-monthly washing of their mattress covers. This is not appropriate in our area and will result in an unacceptably high accumulation of Der-p-1 antigen on the mattress surfaces.

The reduction of the Der-p-1 allergen pool, especially the faecal pellets and dead mites, remains largely unresolved.

Reduction of indoor humidity[9] appears to be an effective means of controlling the mite population in the household; however, this is not affordable and practical for most patients. Washing of the bedding is effective at temperatures greater that 70°C and may be more appropriate here. Removal of carpets, heavy fabrics and soft toys is strongly advised and acaricides may help to destroy any remaining mites.[10]

In conclusion, control of exposure to dust mites remains a largely unresolved problem. It is clear that the use of only one method of control, i.e. special mattress covers, acaricides, or hot washing of fabrics, will only partially alleviate the problem. A comprehensive strategy to utilise all available methods known to be effective in reducing dust mites should be used. Further studies are required to determine whether the application of all known control measures will achieve optimal levels in areas of high mite prevalence. We also need to know what level of reduction of Der-p-1 is required to produce an improvement in the patient's condition.

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