

House dust mite allergy and anti-mite measures in the indoor environment

H. HARVING, L. G. HANSEN, J. KORSGAARD, P. A. NIELSEN, O. F. OLSEN, J. RØMER, U. G. SVENDSEN & O. ØSTERBALLE

INTRODUCTION

House dust mites occur in many Danish dwellings, but the majority of the residences do not contain a mite population (1). This uneven distribution shows that it is possible to have dwellings free of mites. Effective prevention must therefore involve a change in environmental factors that separates houses with elevated mite counts from “normal” dwellings. Considering which factors determine the numbers of mite counts in dwellings, it has been shown that it is not nutritional limitation that determines the number of mite counts, but the humidity in the houses (2). Abnormally high mite counts are found in dwellings with air humidity above 7 g/kg air during the dry winter months (3).

Changes in environmental conditions by moving people with asthma and house dust mite allergy to an environment free of house dust mites result in an improvement of their clinical condition (4,5). This shows that it is a relevant approach in the treatment of house dust mite asthma to try to reduce exposure to house dust mites (secondary prevention). Furthermore, a reduction in population exposure to house dust mites most likely will result in a decreased incidence of allergy to house dust mites (primary prevention) (6).

METHODS TO REDUCE HOUSE DUST MITES

Efforts to reduce house dust mite exposure can be made using two fundamentally different strategies:

1. preventing mite infestation by changing factors in the indoor environment to decrease humidity; and
2. eradication procedures against house dust mites in selected areas of the dwelling (the bedroom, the mattress, etc.)

INVESTIGATIONS CONCERNING GENERAL CHANGES OF THE INDOOR ENVIRONMENT

Mechanical ventilation systems in dwellings

In order to prevent the occurrence of house dust mites, it seems obvious to reduce air humidity by increasing ventilation in houses with high mite counts, where the high humidity is not due to water damage from leaky construction or extremely high moisture production of the inhabitants. An increase of air exchange and low humidity is most effectively achieved by installation of a mechanical ventilation system (7).

The only controlled investigation dealing with ventilation systems as a preventive measure in house dust mite allergy has been carried out in Århus, Denmark (8). This study evaluated a healthy-building project which included a mechanical ventilation system, securing a high ventilation rate in the dwellings. Air inlet was placed in all the living- and bedrooms while exhaust air was taken from the most damp rooms, i.e. kitchen and bathroom.

The study consisted of an evaluation of allergic persons and their indoor environment before

and after moving into the new flats. A clinical examination included registration of symptom score, medicine score and PEF during a one month period. Persons with mite allergy all had the diagnosis verified with bronchial provocation test with extract of house dust mite. The houses were examined concerning ventilation rate, air humidity, and counts of house dust mites. The clinical and indoor environmental investigations were carried out with one year intervals, before and after moving into the experimental flats. The total observation period lasted 1–1.5 years.

The indoor investigations were carried out in the same manner in the new houses as it was done in the former residences. Comparison showed that the average air exchange rate increased from 0.3 to 1.3 per hour. In accordance with this, the indoor air humidity in the new dwellings was significantly lower than in the old ones. Concerning the house dust mite count, a significant decrease was registered after one year. Sixteen families had increased mite counts ($> 100/\text{g}$ dust) before moving into the flats. Out of this group 11 families registered total disappearance of the mites, mostly in their old mattresses. As far as the clinical outcome was concerned, a significant improvement was registered subjectively as well as in objective parameters such as medicine score, FEV1 and PEF in persons with asthma due to house dust mite allergy. The improvement was highly correlated with changes in house dust mite counts.

The above-mentioned investigation is the first to demonstrate that it is possible completely to remove house dust mites from mattresses, where they formerly were found in elevated numbers. The investigation has furthermore confirmed the close relationship between indoor air humidity and the prevalence of house dust mites. It was concluded that the high ventilation rate due to the mechanical ventilation system was the major cause of low indoor humidity and thus to the disappearance of the house dust mites in 11 of 16 families.

Devices for air dehydration

It is now possible to purchase mobile air dehydrators for use in residences, with a capacity

sufficient to extract the moisture created by human activities in a dwelling. From a theoretical point of view these devices should be able to maintain sufficiently dry conditions to prevent growth of house dust mites.

No investigation has been carried out concerning the effect of these devices in daily use. A pilot study (University Hospital of Århus, DK) in 3 families with elevated house dust mite counts in their residences and with children allergic to house dust mites did not show any significant changes in mite counts or clinical conditions of the children during use of dehydrators for 1 year. Due to a substantial amount of heat from the devices, a marked increase in temperature during use was registered in the children's bedroom.

REDUCTION OF HOUSE DUST MITES IN PLACES WITH HIGH MITE CONCENTRATION

Dust avoidance measures

The most widespread treatment recommendation for mite avoidance has been to intensify domestic cleaning, mainly concentrating on the bedroom where the house dust mites occur in the highest number. Recommendation of cleaning procedures has consisted of intensive vacuum-cleaning, high frequency of linen-washing and often steps have been taken to exchange material and to remove carpets to achieve smooth surfaces easy to clean. Furthermore, plants and pets have been removed from the bedrooms. Finally, increased ventilation by increased window opening has been recommended.

Looking at the scientific basis for these recommendations, four controlled trials concerning this issue have been carried out. Two of these demonstrate a positive impact of these procedures, either concerning mite counts and/or clinical improvement, while the other two studies did not find any significant changes.

The most frequently quoted paper demonstrating a positive impact of intensified cleaning has been carried out by Murray et al. (9), who

followed 20 children with asthma and positive skin prick test to house dust mites. Half of the patients followed the prescribed intensive cleaning programme and removal of furniture and carpets from the bedroom. Pillows and mattresses were sealed in vinyl covers. The observation period was one month, after which a clinical improvement in the study group was demonstrated on symptom score, peak-flow, and PC₂₀ of histamine. No measurements of change in mite exposure were made in the houses.

The results are weakened by a short observation period, no information on mite exposure and poorly characterized patients concerning the diagnosis house dust mite allergy, the only criteria being positive skin prick test. Furthermore, pets were removed from a number of the homes without any indication of a possible impact of this removal on patients with concomitant pet allergy.

Another study with a positive result (10) was carried out with 22 adults in a study group and 20 adults as controls. These patients, who all had a positive skin prick test to house dust mite, were followed during a year with measurements of clinical parameters and counts of house dust mites every four months during the test period. In the study group, rigorous measures were instituted, including sealing of mattresses and pillows in plastic and changing linen to a synthetic type. Blankets were removed if possible and all beddings were washed every week. Carpets were removed from the bedroom and the floor was washed very often. All unnecessary furniture was removed from the bedroom. Frequent vacuum-cleaning was recommended on carpeted floors. The bedroom should be ventilated intensively on dry days.

The investigation showed a positive effect concerning reduction in house dust mite number from 700/m² to around 100/m².

Concerning the clinical improvements, no effect was found in the study group as a whole. Only when this group was divided into "strongly allergic" (RAST class 3 for *Dermatophagoides pteronyssinus*) and "non-allergic" (defined as RAST-class less than 3 for *D. pteronyssinus*) was effectiveness demonstrated at a statistically sig-

nificant level of 1-5% concerning PC₂₀, medicine score, and PEF in the group with the high RAST class.

The investigation had a long period of observation, but it was not blinded. A positive result was only achieved by an artificial division of RAST classes in the group that employed the intensive cleaning programme.

On the other hand, an investigation by Burr et al. (11) did not show any effect of anti-mite measures. In this investigation a study group of 26 mite-allergic persons was followed for a period of eight weeks and compared with a control group of 27 persons. During the observation period the active group undertook a cleaning programme consisting of vacuum-cleaning once a week, washing bedding once a week, removal of blankets and toys and vacuum-cleaning of carpets and bedrooms several times a week.

In the other group a placebo programme was carried through using "dust-binding spray" and frequent cleaning in the dining room.

The investigation was carried out double-blind and the evaluation of the test persons revealed no significant differences between the two groups. Both groups showed a trend towards improvement during the observation period. The mite counts remained unchanged. The study was weakened by a short observation period and was criticized for not including plastic sealing of mattresses and pillows (12).

Korsgaard (13) studied 46 persons with house dust mite allergy allocated into a study group and a control group. After 12 weeks of baseline measurements the study group started a cleaning programme including cleaning of mattresses and change of bed linen twice a week. The bedroom was intensively ventilated twice daily for 20 minutes and during the rest of the day a small window was kept open constantly. Carpets were removed from the bedroom and all pillows were exchanged with a synthetic type. During the following 12 weeks a reduction in dust amount in the bedroom was found but no changes in air humidity or in numbers of house dust mites. Furthermore, the clinical condition in the patients did not show any objective signs of improvement.

The investigation is detailed with a long baseline period being compared to the experimental period. The cleaning procedures were extensive, but did not imply sealing of mattresses and pillows. The investigation showed no change in objective disease parameters, but an improvement in symptom score.

Chemical procedures

A number of acaricides are known *in vitro* to be effective against house dust mites. Only a minority of these chemicals are of sufficiently low toxicity to be used as a pesticide in buildings.

Experiments have been made employing Nattamycin (14, 15) without convincing results.

Another chemical still being investigated are derivatives of esters of benzoic acid (benzylbenzoic acid). Two German studies (16, 17) find a positive effect. In the latter, uncontrolled study a reduction in mite counts and improvement in objective and subjective parameters was registered concerning asthma and rhinitis in an observation period of 3 months.

Another product containing a combination of benzo-derivative and tannic acid is commercially available. No results have been published on the possible effects of this preparation.

It can be concluded that studies of possible effect of acaricides are too few to decide whether these methods can be used.

Freezing

Freezing with liquid nitrogen has been used in one study (18). During an observation period of 2 months a reduction of living house dust mites but not in the total mite material was registered comparing treated and untreated mattresses. No clinical evaluation was carried out in this study.

Heating blankets

In order to increase temperature and thus locally reduce humidity (19), electric heating blankets have been used in beds with elevated mite

counts. The experiment was carried out on used mattresses, 10 beds being treated with heating blankets and 10 control beds both followed with mite counts regularly through one year. The beds with heating blankets showed a reduction of relative humidity and mite counts were reduced by 50%. The blankets were in no case able to totally remove the mites. The investigation did not include any clinical evaluation.

CONCLUSION

House dust mite allergy is closely associated to the indoor environment and the concentration of house dust mites is correlated with the absolute indoor humidity. A reduction or removal of house dust mites can be expected to have a positive impact on symptoms in persons who suffer from allergy to these mites.

An investigation from a healthy-building project with a mechanical ventilation system has shown that house dust mites disappear in 2/3 of the families who formerly had elevated mite counts. Simultaneously an improvement was found in symptoms in persons allergic to house-dust mites. These results confirm the relationship between indoor air humidity and mite occurrence and strongly imply that an increased ventilation rate, in this case through a mechanical ventilation system, is the main cause of this result.

Many attempts have been made to reduce the occurrence of house dust mites through implementation of dust avoidance programmes, i.e. removal of carpets, change of building materials, and sealing of mattresses in plastic. The published controlled studies have shown contradictory results and at present there is a lack of scientific evidence of a positive impact of this procedure in persons with house dust mite allergy.

From a theoretical point of view, house dust mite eradication may be efficient using other methods including chemicals, local change of temperature and humidity in mattresses and employment of air dehydration in dwellings. These methods are, however, at the moment not sufficiently investigated to be recommended for general use.

On the basis of the scientific documentation, the following can be concluded:

1. Reduction of indoor air humidity in dwellings is a positive measure. Different methods to reduce humidity are available but the most effective method is controlled air exchange through mechanical ventilation systems. Investigations imply that a high ventilation rate in dwellings obtained through a mechanical ventilation system can reduce indoor air humidity (7, 8). Subsequently house-dust mites are removed in a majority of the dwellings where the families formerly had elevated mite counts (8).
2. Implementation of rigorous programmes for house dust mite eradication including intensive cleaning, change of furniture, sealing of mattresses, etc. is at the moment without sufficient scientific justification.
3. Chemical methods to reduce house dust mites in dwellings should be further investigated in order to reveal whether these methods are effective in practical use.
4. Electric blankets do not seem to be able to remove or to a substantial degree reduce the occurrence of house dust mites in beds.
5. No investigations are available concerning the impact of air dehydrators on the occurrence of house dust mites in houses.

Practical measures

The most important measures in primary and secondary prevention of house dust mite allergy must involve procedures that can secure sufficiently dry conditions in dwellings. This can most effectively be done by achieving a ventilation rate sufficiently high to remove the water vapour being produced by daily use of the dwelling. It is therefore recommended that patients with house dust mite allergy and high exposure to house dust mites increase their ventilation at home.

The most effective method to increase air-exchange rates in houses is at present installation of mechanical ventilation systems with heat recovery. It seems thus logical in selected cases to recommend installation of these systems in existing dwellings. The indications should be:

1. An allergological examination done by specialists confirming that the patient's symptoms to a major degree are due to allergy to house dust mites.
2. The patient must have asthma of an intensity that reduces his daily activity, despite optimal treatment.
3. A documented high exposure to house dust mites in the dwelling.
4. Technical evaluation of the dwelling must exclude defects in the building as a cause of damp problems, i.e. leaky construction or uncommonly high moisture production.

Aggressive cleaning procedures imposed on the families with house dust mite allergy are without sufficient scientific documentation.

Future research

Further investigations should be carried out concerning the indoor environment and house dust mite allergy in different areas.

1. Investigation concerning the impact of mechanical ventilation systems installed in existing houses.
2. Investigation of alternative methods for securing a sufficiently low air humidity, including changes in building construction and possibly investigations concerning air dehydrators.
3. Studies of dust avoidance, i.e. intensive cleaning, changes of material, and plastic sealing of mattresses and pillows concerning the clinical outcome on persons with house dust mite allergy are needed.
4. Investigation of chemical eradication as far as the clinical impact, side effects, and environmental consequences are concerned.
5. Investigations of heating and freezing procedures of mattresses in order to reduce mite counts with evaluation of possible clinical impact on mite allergy.

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