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Atopic Dermatitis and The Indoor Climate

The Effect from Preventive Measures

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Nine patients with atopic dermatitis (AD) were clinically evaluated before and after moving to new houses with improved air exchange, low relative humidity and optimal temperature control. During a 2-year period three clinical and subjective assessments were performed each month of disease activity, and compared with changes in suspended and respirable dust particles, room temperature, air exchange rate, concentration of house-dust mites in bedrooms, and the concentration of organic solvents in the indoor air. Ten matched patients with AD, who did not move, served as a control group. The skin condition of patients moved improved significantly after moving. The indoor climate was improved on: 1) air exchange rate, 2) relative humidity, and 3) room temperature, but the amounts of house dust mites, respirable air particles and organic solvents were unchanged. The clinical and subjective improvement in AD could not be correlated to any single indoor environmental factor. The present investigation supports the current concept, that AD may be a multifactorial disease, and that the indoor climate may be a contributing factor affecting the eczema. ***Key words: Atopic dermatitis; Environment.***

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Atopic dermatitis (AD) is a multifactorial disease, caused mainly by intrinsic factors (1, 2). Extrinsic factors such as food allergens and other common environmental allergens can influence the intensity of symptoms (3–6).

The purpose of the present study was to evaluate AD in patients before and after moving to new houses, built in order to obtain the best indoor climate (6), i.e. a high air exchange rate, low relative humidity, and a low allergen burden.

MATERIALS AND METHODS

Houses

In 1984 a group of 111 houses were built in Skejby, Jutland, Denmark. The houses were designed to obtain the best possible indoor environment regarding physical and biological factors, evaporation of various chemicals from building material, furnishings and inhabitants (6).

A mechanical ventilation system was installed to reduce the relative humidity by exchanging the indoor air once every hour. Air was removed from lavatories, kitchens and the sculleries, and fresh pre-warmed air was supplied to the living- and bedrooms. Walls and floors had smooth surfaces (vinyl, clinkers, or beechwood parquet) in order to improve effectiveness of cleaning. Evaporation of organic solvents was reduced by use of special silicate wall paints. The wood constructions were mainly of pine, and glue-containing chipboards were avoided.

The houses were frequently mentioned in press media and patients with allergies were encouraged to participate.

Patients

Two groups of AD patients with comparable disease severity were selected from the out-patient clinic.

Group 1 (7 females and 2 males, mean age 23, range 3–47 years) moved house in October 1984. Two of the patients were below 10 years old. Eight of the patients had concomitantly asthma and/or rhinitis, and 3 had irritant hand eczema.

Group 2 (6 females and 4 males, mean age 24 years, range 3–43) stayed in their usual home during the study. They matched group 1 according to age and degree of eczema. Four patients were younger than 10 years. Seven also had BA and/or rhinitis and 1 had toxic hand eczema. This control group did not move during the observation period (1984–86) and they kept the same furnishings and carpets during the investigation period.

None of the patients kept pet animals. In general, no changes took place in occupation or occupational environment during the observation period.

Evaluation

The patients who changed residence (the 'movers'), and the controls were all evaluated clinically in April 1984, 1985 and 1986 at the Department of Dermatology in Aarhus. The

Table I. *Consumption of topical steroids (gram)*

	1984	1985	1986
Controls			
Mean	2.3	1.8	1.6
Range	0.3–8.9	0–6.0	0–6.6
	$p<0.05$	NS	
Movers			
Mean	1.2	1.0	0.4
Range	0–2.7	0.1–3.6	0–1.7
	NS	$p<0.05$	

evaluations in 1985 and 1986 were 4.2 and 15.8 months after changing residence.

The patients were checked weekly during one month each year by the same investigator, who recorded the localization, degree (mild, moderate, severe) and extent of eczema. Erythema, vesicles, itching and lichenification were registered by the patients on a visual analog scale (VAS) ranging from no symptoms (0 mm) to most severe symptoms (100 mm). Change in VAS rating indicated changes in symptoms and was used directly as scoring for subjective disease perception. VAS score was performed daily for 1 month each year.

Topical steroids were used twice daily, and the amount of cream used was recorded four times during a period of one month each year. Treatment with an emollient was allowed *ad libitum*.

Once a year a laboratory screening was performed, including S-IgE, RAST and prick test for house dust mite (*Dermatophagoides pteronyssinus*). Also, patch testing was performed with European Standard Series on all patients with hand eczema.

Indoor climate investigation

The bedroom indoor climate was monitored for all patients by an authorized indoor-climate specialist company (Miljø-Kemi, Galten, Denmark). Once a year (in April) concentrations of suspended and respirable particles, air exchange rate, relative humidity, and room temperature were measured, and the numbers of house dust mites (*D. pteronyssinus*) were counted in the bed mattresses and on the bedroom floor (7). The indoor concentrations of formaldehyde and organic solvents were determined in the homes of 7 patients.

Also, all patients were interviewed about indoor facilities and habits: heating equipment and apparatuses, types of window (single or double glass panes), building construction materials, painting of walls and floors, how often clothes were washed and dried indoors, and how often domestic cleaning took place (vacuum cleaning, sweeping), smoking, humidity observing possible symptoms of the 'sick building syndrome' (6). Questions also concerned the daily consumption of emollient creams.

Statistical methods

The analyses were performed by Mann-Whitney, Wilcoxon and Friedman tests. $p<0.05$ was regarded as significant.

RESULTS

Indoor climate investigation

The amounts of formaldehyde and organic solvents were within the limits recommended by WHO (6), and there were no significant changes after moving, or between the two groups. The air exchange rate increased from 0.11/h to 1.21/h for the movers ($p<0.0005$), and from 0.22/h to 0.29/h for the controls (not significant). The relative humidity was reduced from 44% to 38% in the new houses ($p<0.01$), whereas no changes were found in the houses of the control group. The indoor temperature was significantly decreased for both groups ($p<0.05$). The numbers of house dust mites on the mattresses were significantly decreased in both groups ($p<0.05$), whereas no changes were found in the numbers of mites on the floor. There was no difference in suspended and respirable dust particles between the groups.

The questionnaire concerning indoor facilities and habits did not reveal any changes which might affect the indoor climate during the investigation period.

Patients

Laboratory tests. Three of the 9 'movers' were allergic to house dust mites, as verified by prick test and RAST (class 3–4). Median S-IgE was 780 U/l (range 138–7700).

Three of the 10 AD control patients were allergic to house dust mite by prick test and RAST (class 4). Median S-IgE was 412 U/l (range 38–4610). All tests were repeated in 1985 and 1986. No differences were demonstrated. All patch tests were negative.

Subjective assessment. The 'movers' overall subjective disease score on the VAS was reduced by 43% ($p<0.0005$), indicating an improvement in their skin disease. The control group also improved, with a VAS reduction of 3% ($p<0.02$).

The 4 children in the control group all improved from 1984 to 1985, but 3 had a relapse during the second year. The 2 children in the 'mover' group improved in both periods. One of them had a relapse in 1984–85.

Topical steroids. The 'movers' consumption of topical steroids was reduced 66% in the period 1984–86 ($p<0.001$). The controls had a 30% reduction ($p<0.05$) (Table I).

Clinical evaluations

The clinical score for erythema decreased 67% from 1984 to 1986 ($p<0.005$) for the 'movers' group, while

the controls increased by 35% ($p<0.02$). The score for vesicles decreased 70% for the 'movers' ($p<0.05$), and a non-significant increase of 8% was observed for the controls.

The score for itch was decreased 78% ($p<0.02$) for the 'movers', but increased 15% for the control group ($p<0.05$). Lichenification was unchanged in the control group, and decreased 50% (non-significant) for the 'movers'.

The irritant hand eczema in the 3 'movers' disappeared, while it remained unchanged in the control group.

In April 1987, one year after completion of the study, a follow-up questionnaire was sent to the 'movers'. The results showed that a good subjective skin condition was maintained in 8 'movers', while one had had a severe relapse.

DISCUSSION

The beneficial clinical effect, which was observed on AD 1–2 years after moving to a 'mini risk' house may be due to a combination of both environmental and other factors (9). In the present study the results may have been biased by the relatively small number of patients who were willing to move home in order to participate in the study. Also, the controls had to be selected from a group of patients who were unable or unwilling to move even though they were offered the opportunity. Most likely the 'movers' were interested, 'allergy aware' persons, prepared to face the social and economic problems of moving home. The clinical scores of erythema, vesicles, scaling, and lichenification were in accordance with the subjective evaluation, and the improvement in AD of the 'movers' was both clinically and subjectively postponed until the second year. This improvement was independent of the initial severity of the eczema, and the delay may have been due to psychological stress related to the moving, and to degassing of components of the new houses.

The improved overall subjective skin condition of the controls after the first period may have been a result of a more careful attention and treatment during clinical control and follow-up. This is in contrast to the subjective effect of individual disease parameters, scored on a VAS scale, where the controls reported more reddening and itching during the first period. In the second period the skin returned to its initial status.

In both groups the children improved during the first observation period. The 2 children in the 'mover' group, improved in the second period after an initial deterioration. During this time the children of the control group relapsed, which indicates that indoor climate factors may influence on AD.

The better skin condition in the 'mover' group was not due to increased use of topical steroids. This was established by the observed correlation between better overall assessment, decrease in erythema, vesicles, itching, lichenification, and decreased use of topical steroids.

Nexmann (9) reported an immediate clinical improvement of the skin in new surroundings. The delayed improvement in our investigation may be anticipated, because only part of the indoor climate was changed. The 'movers' brought their old furnishings into the new houses and, most important, the beds and mattresses were not replaced. In spite of low-to-normal concentrations of allergens and irritants, a long time may be needed to dilute irritants and antigens to a level below the symptomatic threshold.

The air exchange rate in the 'movers' houses increased about ten-fold. None of the 'movers' reported any discomfort due to the increased air velocity or decreased temperature in the rooms. The relative humidity was gradually reduced, but significantly only in the second period, probably due to initially increased humidity of new construction materials.

Increased air exchange rate and hence a lower relative humidity has been found to reduce the numbers of house dust mites (7) but this was not demonstrated in the present study, probably due to an initial low concentration of mites before moving. In only 7 cases were determinations of organic solvents in the air performed. The results showed that both formaldehyde and organic solvents were reduced, after a slight increase in 1985 due to evaporation from the new building materials.

When the indoor relative humidity is lowered, an increased sensation of itch might be expected, but 70% of the 'movers' reported that itching even decreased. The consumption of emollients was unchanged in the first period and decreased in the second. This might also indicate a better general skin condition.

The present investigation has shown improvement in subjective symptoms and clinical status of AD in patients after moving to 'mini-risk' houses, which differ from ordinary buildings by virtue of their increased air exchange rate and low indoor relative

humidity. No single factor, however, could be associated with changes in clinical signs and symptoms. These observations support the opinion that AD is a multifactorial disease and that the indoor climate may be only one of many factors affecting the atopic skin condition.

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