

Report

House dust mites on skin, clothes, and bedding of atopic dermatitis patients

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Abstract

Background Atopic dermatitis is a common allergic condition in children, often associated with a positive skin reaction to house dust mite allergens.

Aim To determine the presence of house dust mites on the skin, clothes, and bedding of patients with atopic dermatitis.

Methods Nineteen patients with atopic dermatitis were examined during a 2-year period. Samples from affected and healthy skin surfaces were obtained with adhesive tape, and dust samples from bedding and clothes were collected with a vacuum cleaner at the start of the study and 3–6 weeks later, and examined for the presence of house dust mites. The findings were compared with those of 21 healthy controls.

Results The most common mite species on skin were *Dermatophagoides pteronyssinus* and *Dermatophagoides farinae*, which were found in nine patients and three controls. The patient group showed a significantly larger percentage of samples with mites than did the control group (34.9% and 7.9%, respectively) ($P < 0.001$), and a significantly larger percentage of individuals with at least one positive sample (84.2% and 14.2%, respectively) ($P < 0.0001$). No correlation was found between the number of mites on the skin and clothes/bedding of patients, or between patients and controls with regard to the number of mites on the clothes and bedding.

Conclusions Patients with atopic dermatitis showed a higher prevalence of mites on their skin than did healthy individuals, which could be involved in allergic sensitization and disease exacerbation.

Introduction

Atopic dermatitis (AD) is a common form of allergy, affecting more than 20% of children in affluent countries.¹ Its reported prevalence rate in 13–14-year-olds in Israel is 7.8%.^{2,3} AD is the first manifestation of the “atopic march,” and a risk factor for the subsequent development of bronchial asthma and allergic rhinitis.

Sensitization to house dust mite (HDM) allergens is a high-risk factor for the development of allergic diseases.⁴ Its role in AD was first discovered following the observation of both immediate and delayed-type skin reactivity to mite antigens in affected patients,^{5,6} and the beneficial effect of the environmental control of mites on the course of the disease.^{7,8} In patients with AD, the presence of anti-HDM immunoglobulin E (IgE) frequently coexists with allergic rhinitis and/or bronchial asthma.¹ In these cases, the preferential route of sensitization to HDM probably begins in the upper and lower respiratory tract, after inhalation of HDM allergens. Darsow *et al.*⁹ reported a positive patch test to HDM antigens in 40% of patients with AD. In these patients, sensitization to

HDM may involve the transdermal route. To cause transdermal sensitization, HDM allergens must be absorbed through the skin, processed by dendritic cells, and presented to T-helper lymphocytes. For efficient absorption, close and prolonged contact between the skin and HDM allergens is probably necessary, for example, via HDM-contaminated clothes and bedding. Accordingly, several studies have reported that the homes of patients with AD contain large amounts of HDM and their antigens, compared with controls,¹⁰ and that clothes and bedding are an important source of HDM.^{11–16}

The aim of the present study was to determine the presence of HDM on the skin of patients with AD, and to correlate their numbers with the number of mites found in bedding and clothes.

Patients and Methods

Patients

The study group consisted of 19 children with a diagnosis of AD who were treated at our center from June 2002 to June 2004. The diagnosis of AD was based on the modified criteria of Hanifin and Rajka.¹⁷ Exclusion criteria were as follows: age less than

2 months, presence of “weeping eczema”, active bacterial skin infection, and infestation with scabies mites or lice. The patients and their parents were instructed to discontinue all long-acting antihistamines and systemic or local corticosteroids 2 weeks before entering the study. Skin treatment with emollients alone was permitted, as were short-acting antihistamines. Patients were assessed with the SCORing Atopic Dermatitis (SCORAD) index,¹⁸ skin prick tests for mite, airborne, and food allergens, and patch tests with *Dermatophagoides pteronyssinus* antigen 1 (Der p1) and *Dermatophagoides farinae* antigen 1 (Der f1) extracts. The SCORAD assessment and tests for the detection of HDM were repeated 3–6 weeks later. The findings were compared with those of a sex- and age-matched randomly selected group of 21 pediatric ambulatory patients who had no evidence of AD and were living in the same geographic area as the patients.

Detection of mites on the skin

Skin surface samples were obtained by applying 5 × 5-cm² strips of transparent adhesive tape to the skin and removing them immediately. Each piece was applied eight times to 50% overlapping skin areas, so that each sample was collected from 100 cm² of skin surface for each patient and control subject. The sites tested included the antecubital, upper back, and popliteal areas. In the patient group, additional samples were obtained from nonaffected skin areas.

All samples were examined under a stereomicroscope (× 40) by an examiner who was blind to the group allocation. Mites were identified at magnifications of ×100 and ×1000 according to the guidelines of Hughes.¹⁹

Detection of mites in clothes and bedding

The patients' clothes and bedding were vacuumed with a conventional 2000 W vacuum cleaner (Foron 2000, EIO). A piece of thin, fine-weave cotton cloth (10 × 10 cm²) was placed between the vacuum cleaner and the extension tube so that the dust could be collected on the cloth. The everyday clothes worn by each patient until the day preceding the examination (shirts, T-shirts, shorts, and trousers) were analyzed separately from the clothes that had not been worn, dry-cleaned, or laundered in the last 3 months, and from bed sheets, pillow cases, and blankets/duvets or their covers used by the patient during the last week. Each category of material was vacuumed for 3 min. The dust was stored at –20 °C until examination for mites or antigens.

Statistics

Data analysis was carried out with SPSS software (SPSS Inc., Chicago, IL, USA). For continuous variables, such as age and laboratory parameters, descriptive statistics were calculated and reported as the mean ± standard deviation. The normalcy of the distribution of continuous variables was assessed using the Kolmogorov–Smirnov test (cut-off at $P = 0.05$). The means of continuous variables were compared with the t -test for independent samples. Categorical variables were compared using the chi-squared test. All tests were two-sided and considered to be significant at $P < 0.05$.

Results

The personal and clinical characteristics of the 19 patients are shown in Table 1. The study group included 13 girls and six

Table 1 Patient characteristics, allergic background, and SCORing Atopic Dermatitis (SCORAD) index

Patient	Age (years)/sex	Other allergic diseases	SPT for HDM	Other SPT	IgE (IU/mL)	Eosinophil counts (μL)	Atopy patch test	SCORAD
1	5/Female	Yes	POS	POS	7190	1200	POS	39.4
2	2/Female	Yes	POS	POS	2464	1300	POS	57.3
3	17/Female	Yes	POS	NEG	ND	ND	ND	56
4	5/Female	No	POS	NEG	1144	690	POS	64.4
5	2/Female	No	NEG	NEG	62.8	480	ND	74.5
6	5/Female	No	NEG	NEG	20.8	310	POS	37.6
7	1/Female	No	NEG	POS	212.4	900	POS	83
8	5/Male	Yes	POS	POS	704.6	990	ND	53.9
9	9/Male	Yes	POS	POS	538	390	ND	21.7
10	9/Male	Yes	POS	POS	329	440	ND	21.2
11	31/Female	Yes	POS	NEG	99000	420	ND	95.8
12	1.9/Female	Yes	POS	POS	212.4	900	ND	67.5
13	15/Female	Yes	POS	POS	725	380	ND	38.9
14	6/Female	Yes	POS	NEG	1076	1810	POS	31.8
15	10/Male	Yes	POS	POS	2000	500	POS	55.2
16	17/Female	Yes	POS	POS	1980	820	NEG	46.1
17	2/Male	Yes	NEG	NEG	24	140	POS	34.1
18	6/Female	No	NEG	NEG	ND	ND	NEG	37
19	1.9/Female	No	NEG	NEG	2000	120	ND	35.3

HDM, house dust mite; IgE, immunoglobulin E; ND, not detected; NEG, negative; POS, positive; SPT, skin prick test.

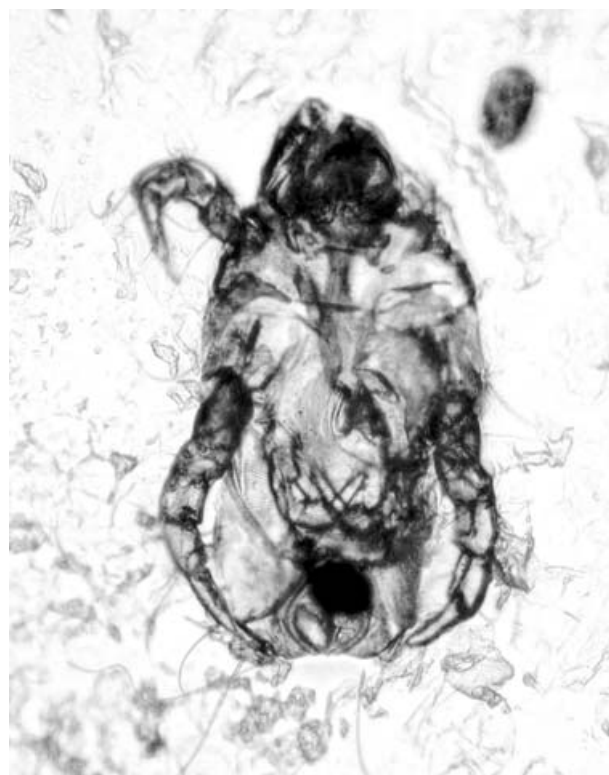
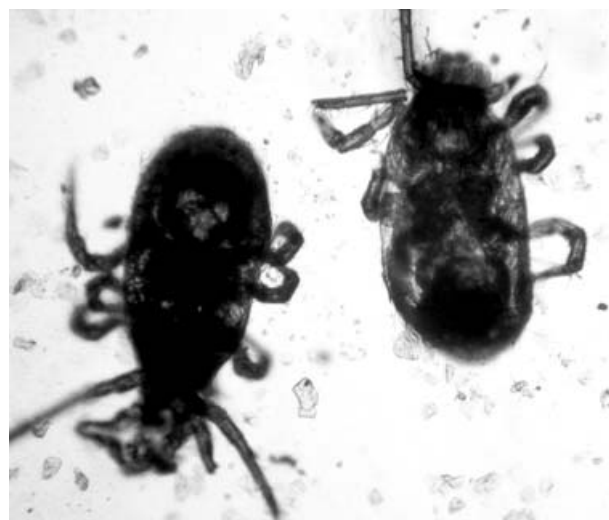
Table 2 Infestation of patients with atopic dermatitis (AD) and control individuals with mites and insects

	AD patients	Controls	P value
Individuals examined	19	21	
Skin samples examined	86	63	
Positive skin samples	30 (34.9%)	5 (7.9%)	< 0.001
Individuals with at least one positive skin sample	16 (84.2%)	3 (14.2%)	< 0.0001
Total examinations	34	21	
Examinations positive for mites and/or insects	22 (64.7%)	3 (14.2%)	< 0.001

boys with an average age of 7.8 years. All patients suffered from AD. Thirteen patients also had allergic rhinitis and/or asthma. All of these patients had a positive skin prick test to HDM allergens and very high levels of total IgE and eosinophilia. Six were also patch tested, and four were found to be positive for HDM. Five of the six patients without rhinitis or asthma had a negative skin prick test to HDM allergens; their level of IgE was lower than in the asthma/rhinitis subgroup, although still above normal. Three had a positive patch test to HDM. The remaining patient without a respiratory disorder had a positive skin prick test to HDM, a high level of IgE, and a positive patch test.

Fifteen patients were examined twice and four patients once, for a total of 34 examinations. Eighty-six skin surface samples were obtained from the study group (average, 4.5 samples per patient) and 63 samples from the 21 control subjects.

Mites were detected in a significantly larger percentage of skin samples taken from the patients than from the controls (30.6% vs. 7.9%) ($P < 0.001$). The patient group was also characterized by a significantly higher percentage of individuals with at least one positive sample (84.2% vs. 14.2%) ($P < 0.0001$), and a significantly higher proportion of positive examinations for mites (64.7% vs. 14.2%) ($P < 0.001$, Table 2). No significant difference in the number of mites was found between affected and healthy parts of the patient's skin. Fifty-six mites (Acarina) were detected on the skin of patients and five on the skin of control individuals. The most prevalent species were *D. pteronyssinus* (Fig. 1) and *D. farinae*, detected in samples from nine patients (47.3%), on both involved and noninvolved skin, and from three control subjects (14.2%). The hypopus stage of nonidentified astigmatid mites (probably *Acarus* sp.) was detected in nine patients, either alone (three patients, 15.8%) or in association with other mite species (six patients, 31.6%). Hypopi were not detected in any of the controls. Other species of the orders Mesostigmata (Fig. 2) and Prostigmata (family Tydeidae) were found in one patient each. In seven samples, insects (Insecta) belonging to the order of booklice (family Psocidae)

**Figure 1** *Dermatophagoides pteronyssinus* isolated from the skin of a patient with atopic dermatitis**Figure 2** Mesostigmatid mite found on the skin of a patient with atopic dermatitis

and other unidentified insects were found in addition to mites, and, in one sample, insects were found, but not mites.

Mites were isolated from all samples from patients' clothes and bedding. *D. pteronyssinus* was present in 86.0% of

samples, *D. farinae* in 58.1%, *Euroglyphus maynei* in 20.3%, *Blomia* sp. in 2.3%, and *Cheyletus* sp. in 6.9%. Unidentified specimens of Astigmata, Mesostigmata, and Prostigmata (Tarsonemidae) were each present in 2.3% of the dust samples examined. There were no differences in the mite concentrations in bedding (766.5 ± 1135.27 species/g of dust), everyday clothing (463.1 ± 548.3 species/g of dust), and stored clothing (549.5 ± 1013 species/g of dust). There was no correlation between the numbers of mites found on the skin and those found on clothes and bedding.

In the controls, HDMs were found in 88.9% of dust samples from clothes and bedding: *D. pteronyssinus* in 61.1%, *D. farinae* in 55.6%, and *E. maynei* in 5.6%. There was no difference in the mite concentration between the patients' clothing and bedding and the control clothing (521.0 ± 637.8 species/g of dust).

Discussion

The main biotopes of HDMs are bedding, sofas, carpets, cupboards, and soft toys.^{11,20} HDMs have been found on the clothes of children and adults,^{11–15} and *Dermatophagoides* mite allergens have been demonstrated on human skin surfaces.^{16,21}

Dermatophagoides schereemetewskyi (= *D. pteronyssinus*) was found by Bogdanov in 1864 on the skin of patients with scabies in Moscow.²² This mite was also detected on the skin of a patient with persistent dermatitis in Massachusetts, and on a patient with a *Trichophyton purpureum* infection in the USA.²³

In the present study, only a small part of the skin surface was examined, and mites were found in 84.2% of patients with AD. The frequency of colonization and the density of mites might have been higher had the entire skin surface been examined. In the control group, significantly less mites were detected (14.2%).

The higher prevalence of mites on the skin of patients with AD could be explained by the larger numbers of mites in their environment (clothes and bedding), increased passive adhesion to inflamed skin, or increased active movement of mites and insects to hyperkeratotic skin.

In our study, there was no evidence to support the first assumption, as no difference in mite concentration was found between the patients' clothes and bedding and the control clothes, although an earlier study had reported larger numbers of HDMs in the mattresses of patients with AD when compared with controls.¹⁰

The adhesive band technique was used in this study to detect mites on human skin. This method has been used for the detection of ectoparasites, such as scabies and *Demodex* mites. To our knowledge, this is the first time that it has been used to detect HDMs on the skin of humans. This method provides an "instant picture" of skin fauna, but it cannot

differentiate between passive adhesion to the skin of dead or live mites and active movement of mites to the skin.

Sensitization to stored food mites of the family Tyroglyphidae in urban dwellers has been reported in Spain, Denmark, Germany, and the USA.²⁴ Hypopi stages appear between the first and third nymphal stages of some stored food mites, such as *Acarus* and *Glycyphagus*, when the environmental conditions are unfavorable for their development.^{25,26} Dermatitis associated with hypopi stages of astigmatid mites has been reported in a horse with hypotrichosis and alopecia on the neck, masseter, and left suborbital regions.²⁷ Acarodermatitis is an occupational disease of bakers and farmers caused by the stored food mites of the families Tyroglyphidae, Acaridae, and Glycyphagidae. The saliva and excrement of the mites are believed to have an irritating effect on human skin and give rise to erythematous and papulovesicular eruptions.²⁰ Norval and McPherson²⁸ reported a case of dermatitis in a horse caused by *Acarus farinae* (*Acarus siro*).

Tydeid and mesostigmatid mites were found in our study on the skin of one patient each and in none of the controls. Species belonging to these groups of mites have been detected previously in the human environment and may be of importance in human allergy.^{29–32}

Booklice (Psocoptera) are ubiquitous domestic and industrial arthropods. It has been shown that they are an important indoor allergen in India, causing IgE-mediated responses in 20% of the allergic population studied.^{33,34}

Dermatophagoides species are apparently the most prevalent mites on human skin and the source of the most potent allergens. There is some, although limited, cross-reactivity between *Dermatophagoides* and other mite species, and even insects such as cockroaches,²⁴ which perhaps increases the load of allergens on the skin of AD patients.

The presence of mites on the skin suggests a transdermal route of HDM sensitization. The two main requirements for the development of atopic sensitization are heredity and prolonged and close allergen exposure. In a previous study with a highly sensitive enzyme-linked immunosorbent assay (ELISA), small amounts of *Dermatophagoides* allergen were found on the skin of healthy volunteers.¹⁶ Our study showed that skin contact with the whole mite is not unusual. In two studies,^{35,36} application of the whole bodies of *D. pteronyssinus* and *D. farinae* mites to the skin yielded positive patch test results in AD patients. According to these data, their presence on the skin may have a disease-exacerbating effect in patients with AD who are allergic to HDM.

The results of this study support our hypothesis that HDMs passively or actively adhere to the skin for prolonged periods of time. This makes it possible for the mite allergens to be absorbed by the epidermis and processed by dendritic cells, thereby initiating an immune response and ultimately leading to HDM allergy. Absorption may be more efficient if the skin is inflamed, as in patients with AD. The predilection

of AD skin to frequent infection with various pathogens (yeasts, viruses, and *Staphylococcus*) has been confirmed previously. The underlying mechanism appears to be a decrease in protective local immunity of the affected skin. These pathogens not only cause immediate clinical symptoms, but also lead to immune system activation and specific IgE production, with a secondary allergic response.³⁷

In conclusion, the higher than normal prevalence of mites on the skin of children with AD, as shown here, may point to a sensitizing or disease-exacerbating effect of HDMs in this group of patients.

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