

Diagnosis of house dust mite allergy in asthmatic children: what constitutes a positive history?

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Standardized questions were put to the parents of 530 children, referred consecutively for evaluation of asthma, to determine which features in the history were associated with house-dust mite allergy. Bronchial challenge tests performed on 19 of the children confirmed that there is a highly significant association between a positive skin prick test and a positive bronchial challenge test to Dermatophagoides farinae mite antigen. One hundred and eighteen (23%) of the children had positive prick tests to the mite. There is a highly significant association between a positive prick test to mite and a history that the subject's respiratory symptoms become worse when there is exposure to domestic activity that stirs up house dust (vacuuming, dusting, sweeping, making the bed, or shaking out blankets) or that the symptoms improve when out of doors. Seasonal variation and other features in the history are of little value in distinguishing mite-sensitive from mite-insensitive asthmatics. Although the 4% whose only positive prick test reaction was to mite had significant worsening of asthma during the colder months compared with the remainder, most mite-positive subjects had multiple allergies and had no characteristic seasonal pattern. The presence of a positive prick test to mite was not associated with aggravation of asthma either at night in bed or in the morning on awakening. A history similar to that of mite-sensitive subjects was elicited in those with a positive prick test to house dust. A positive history of house dust or house-dust mite allergy in asthmatics is one in which respiratory symptoms become worse during domestic activity that stirs up house dust or improve when outdoors. (J ALLERGY CLIN IMMUNOL 71:21, 1983.)

House-dust mite allergy is known to be an important cause of asthma in childhood. In some series, as many as 85% of child asthmatics have been reported to have a positive prick test¹ and 87% a positive bronchial challenge test² to house-dust mites. Since most mite-sensitive asthmatics can be improved by making their bedroom dust-free,^{3, 4} and since hyposensitization with mite extract seems beneficial in some studies,⁵ it is desirable to know in which children one should suspect house-dust mite-induced asthma.

The importance of the history in making the diagnosis of mite allergy in asthmatic children is well recognized,⁶⁻¹⁰ but there is uncertainty as to what exactly does constitute a positive history of mite allergy. It is variously held that such patients have perennial symptoms,^{3, 9, 11-13} that they are often worse during the heating season,^{14, 15} that they have exacerbation of symptoms in bed at night,^{9, 11-13, 16} that they are worse in the early morning,^{1, 12} or that they have aggravation of symptoms when exposed to domestic activities such as house cleaning,¹⁷ dusting and vacuum cleaning,⁹ sweeping,¹² or making the bed.^{12, 17} To find exactly which features in the history, if any, are characteristic of mite allergy, we therefore put standardized questions to parents of a large group of asthmatic children and compared the answers with the result of a prick skin test with mite antigen.

A good correlation between prick skin tests and bronchial challenge tests with mite extract has been reported,² and we decided to verify, in a small group of our own subjects, that this was so.

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TABLE I. Association between the response to the prick test and the response to the bronchial challenge test using 1% *D. farinae* extract for both ($p = 0.004$)

	Mite bronchial challenge test			
	Positive		Negative	
	No.	%	No.	%
Mite prick test				
Positive	15	93.8	1	6.2
Negative	0	0.0	3	100.0

METHODS

Population

Those studied were all the children who were newly referred to our allergy clinic from 1977 through 1980 and were said to have had recurrent wheezing or asthma. The study group consisted of 530 children (328 boys and 202 girls) ages 1 to 16 yr (mean age 6.4 yr), who were seen consecutively.

History

A trained interviewer asked the parents standardized questions about the following features: whether or not their child had wheezing, coughing, nasal obstruction, rhinorrhea, sneezing, or itching of the nose¹⁸; whether any of the symptoms were worse in bed at night, in the morning on awakening, or when exposed to house cleaning activities that included vacuuming, sweeping, and dusting; whether they improved when out of doors; and during which months, if any, the symptoms tended to be worse. In the course of the study it was decided to include a question about symptoms during other domestic activities that could result in mite dust becoming airborne; 285 children seen consecutively were asked whether symptoms became worse when the bed was made or blankets were shaken out.

To determine whether information obtained by an experienced physician under usual clinical conditions might bring to light other associations between mite sensitivity and features in the history (beyond those indicated by the epidemiologic methods we used), a pediatric allergist questioned 95 of the parents, this time together with their children. Because histories given by young children are often unreliable, the combined interviews were limited to subjects who were 7 yr of age or older. This subgroup of older children who were questioned in the company of their parents represents all such subjects that had been referred to one allergist. History taking was concluded before skin prick testing commenced.

Tests

Skin tests. After all history taking was completed, skin prick tests were performed with the following allergen extracts: 1% *Dermatophagoides farinae* (Bencard), a mite that is prevalent in our area¹⁹; concentrated house dust (Ben-

card); 5% extracts of dog, cat, and other animal danders (Bencard); 5% extracts of molds (Greer); and 25,000 Noon units/ml of pollens that are airborne in our province (Greer). The resulting wheal was measured in 20 min; a positive test was one with a diameter 2 mm greater than that of the control.

Bronchial challenge tests. To ascertain that there is a positive association between the results of prick and bronchial challenge tests, we studied 19 patients 7 yr of age or older who fulfilled the following conditions: a history suggesting mite allergy (worsening of symptoms in the winter,^{14, 15} at night in bed,^{9, 11-13, 16} in the morning on awakening,^{1, 12} or during domestic activity that stirs up dust,^{9, 12, 17} or improvement when out of doors), moderate to severe recurrent asthma, and consent to have the bronchial challenge test. Increasing concentrations of aerosolized *D. farinae* extract were administered by Wright nebulizer and mask, according to the protocol of Killian et al.²⁰ with minor modifications.²¹ A positive response was recorded if the forced expiratory volume in 1 sec decreased 20% when the child inhaled 1% *D. farinae* extract, or lesser strength, for 120 sec.

Statistical analysis

The chi square test with Yates' correction was used throughout, except in two subgroups: in those who were 7 yr of age or older and in those who had a bronchial challenge test. In these subgroups, Fisher's exact test was employed because of the small numbers.

RESULTS

The skin prick test was positive to *D. farinae* in 23%, to house dust in 29%, to either *D. farinae* or house dust in 40%, and to one or more of all the inhalant allergens tested in 65%. In 4% of the total group of 530 subjects, the prick test to *D. farinae* was the only one that was positive.

Bronchial challenge tests were performed with *D. farinae* extract on 19 subjects, 16 with positive and three with negative skin tests to the same allergen. The severity of asthma in the two subgroups was the same. All but one of those with a positive prick test also had a positive bronchial challenge test. None of the three with a negative prick test to mite had a positive bronchial challenge test (Table I). This confirms the strong positive association between the results of prick and bronchial challenge tests to mites reported by others.^{2, 22}

In the 285 subjects who had been asked all the questions, there was a highly significant association between a positive prick test to mite and aggravation of nose or chest symptoms during domestic activity, such as vacuum cleaning, sweeping, dusting, shaking out blankets, or making the bed, procedures known to stir up large numbers of fine dust particles that are rich in mite antigen.²³ One third of those with a positive

prick test to mite were said to have been noticeably worse in one or more of these circumstances (Fig. 1, *a*). A similar proportion, noticing worsened symptoms, was found in those with an additional or separate sensitivity to house dust (Fig. 1, *b*). The percentage increased to 46% when the child was 7 yr of age or older and was included in the interview, and when the history was elicited by a pediatric allergist (Fig. 1, *c*).

An additional question, whether symptoms improved when the subject is out of doors, increased the proportion of affirmative responses among mite-sensitive subjects to 50% in the whole group (Fig. 2, *a*) and to 62% in the subgroup questioned by the allergist (Fig. 2, *c*). In this subgroup, affirmative responses increased by 35% in mite-sensitive subjects and by only 13% in mite-insensitive subjects, suggesting that it is a useful question to ask in a clinical setting. In the whole group, by contrast, there was an equal increase in affirmative responses from mite-insensitive (52%) and mite-sensitive (50%) subjects, indicating that the standardized question as asked by our trained interviewer was of no value for distinguishing between the two.

In neither the whole group (Tables II and III) nor in the subgroup questioned by the allergist (Table IV) was there a significant difference between those with positive and negative prick tests to mites as regards aggravation of nose or chest symptoms when in bed at night or on awakening in the morning.

Aggravation of asthma during the colder months was significantly more frequent in the 4% who had a positive prick test only to mite than in the remainder of the whole group (Table V, top). However, if the whole group was divided into those with a positive mite prick test and those with a negative mite test, there was no difference between the two. Approximately one third in each were said to have their worst asthma between October and February (Table V, top). Nasal symptoms and cough also were no worse in the winter in mite-sensitive than in mite-insensitive subjects.

In addition, perennial asthma was no more characteristic of mite-sensitive than of mite-insensitive asthmatics, asthma was said to be equally severe all year round by as many with a negative as with a positive test to mite (Table V, bottom). This result was the same for nasal symptoms and cough and was not altered by including house dust-positive with mite-positive subjects (Table V, bottom).

DISCUSSION

The skin prick test appears to be a sufficiently reliable indication of bronchial allergy to be used in an epidemiologic study of mite-sensitivity in children

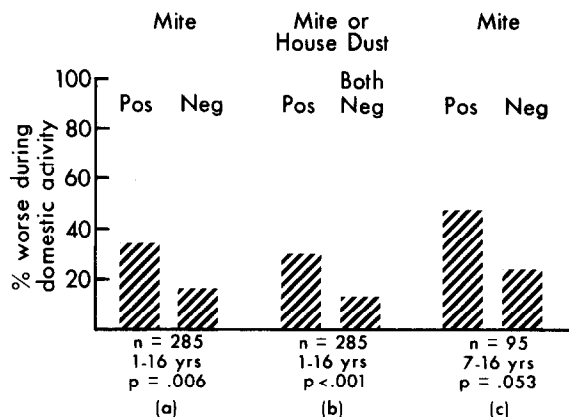


FIG. 1. Association between the results of prick testing and a history of aggravation of nose or chest symptoms during domestic activity such as vacuuming, dusting, sweeping, making the bed, or shaking out blankets in 285 consecutively referred asthmatic children (*a* and *b*) and in a subgroup of 95 asthmatic children 7 yr of age or older who were questioned by an allergist (*c*).

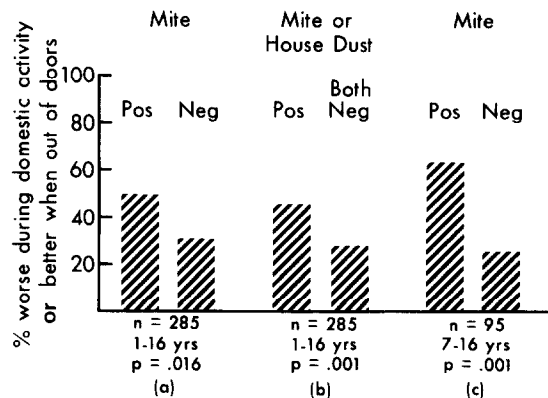


FIG. 2. Association between the results of prick testing and a history of aggravation of nose or chest symptoms during domestic activity such as vacuuming, dusting, sweeping, making the bed, or shaking out blankets, or improvement of symptoms when out of doors, in 285 consecutively referred asthmatic children (*a* and *b*) and in a subgroup of 95 asthmatic children 7 yr of age or older who were questioned by an allergist (*c*).

with asthma. Warner² reported a 94% correlation between prick and bronchial challenge tests with house-dust mite extract, and Cavanaugh et al.²² found a similarly strong association. Our findings support the conclusion that asthmatics with a positive prick test to mites usually (and those with a negative prick test infrequently) have a positive response to a bronchial challenge test with this allergen. Although bronchial allergy to mite does not necessarily mean that this allergen is the cause of the patient's asthma, it is likely that mite-induced symptoms are more common in asthmatics with than without such allergy.

TABLE II. Association between features in the history and results of mite skin testing in 530 asthmatic children*

Symptoms	Mite prick test				p value
	Positive		Negative		
	No.	%	No.	%	
Worse in bed					
Nose‡					
Yes	32	27.4	118	29.5	0.738
No	85	72.6	282	70.5	
Chest‡					
Yes	66	55.9	22	55.3	0.979
No	52	44.1	179	44.8	
Worse on awakening in A.M.					
Nose§					
Yes	44	37.6	121	30.3	0.170
No	73	62.4	278	69.7	
Chest‡					
Yes	34	28.8	103	25.8	0.586
No	84	71.2	297	74.3	
Better outside					
Nose†					
Yes	22	18.6	51	12.8	0.142
No	96	81.4	349	87.3	
Chest†					
Yes	28	23.7	69	17.3	0.146
No	90	76.3	331	82.8	
Worse dusting					
Nose†					
Yes	23	19.5	60	15.0	0.304
No	95	80.5	340	85.0	
Chest†					
Yes	15	12.7	39	9.8	0.451
No	103	87.3	361	90.3	
Worse making beds					
Nose					
Yes	11	17.2	13	5.9	0.009
No	53	82.8	208	94.1	
Chest					
Yes	8	12.5	12	5.4	0.094
No	56	87.5	209	94.6	

*Parents were asked whether symptoms worsened when the bed was made (or blankets were shaken out) in only the last 285 children.

†Data missing in 12 cases.

‡Data missing in 13 cases.

§Data missing in 14 cases.

||285 consecutive cases.

The preeminence of respiratory symptom aggravation during domestic activity that stirs up house dust, as an indication of house dust or house-dust mite allergy, has been appreciated by few physicians¹⁷ and has not previously been shown in a study on house dust- or mite-induced symptoms. Tovey et al.²³ have demonstrated that no mite antigen-containing particles are detectable in the air of undisturbed rooms but that large quantities of fecal pellets rich in mite anti-

gen and small enough to enter the bronchi can be collected from the air during vacuuming, sweeping, and bed making. Some parents notice worsening of the child's symptoms during only one of these activities and not during any other. Therefore a positive history of mite allergy is more likely to be elicited if the history includes all of these domestic activities (Fig. 1) than any one or two of them (Tables II and III). Improvement in symptoms when out of doors is a

TABLE III. Association between features in the history and results of house-dust and/or mite skin testing in 530 asthmatic children*

Symptoms	House dust and/or mite prick test				p value
	Positive		Both negative		
	No.	%	No.	%	
Worse in bed					
Nose‡					
Yes	59	28.6	91	29.3	0.957
No	147	71.4	220	70.7	
Chest†					
Yes	120	58.0	167	53.7	0.385
No	87	42.0	144	46.3	
Worse on awakening in A.M.					
Nose§					
Yes	68	33.2	97	31.2	0.707
No	137	66.8	214	68.8	
Chest†					
Yes	54	26.1	83	26.7	0.959
No	153	73.9	228	73.3	
Better outside					
Nose†					
Yes	35	16.9	38	12.2	0.169
No	172	83.1	273	87.8	
Chest†					
Yes	48	23.2	49	15.8	0.044
No	159	76.8	262	84.2	
Worse dusting					
Nose†					
Yes	42	20.3	41	13.2	0.041
No	165	79.7	270	86.8	
Chest†					
Yes	26	12.6	28	9.0	0.249
No	181	87.4	283	91.0	
Worse making beds					
Nose					
Yes	16	13.3	8	4.8	0.019
No	104	86.7	157	95.2	
Chest					
Yes	15	12.5	5	3.0	0.004
No	105	87.5	160	97.0	

*Parents were asked whether symptoms worsened when the bed was made (or blankets were shaken out) in only the last 285 children.

†Data missing in 12 cases.

‡Data missing in 13 cases.

§Data missing in 14 cases.

||285 consecutive cases.

feature in the history that has not previously been studied to our knowledge. It appears to be a useful additional item for an allergist to elicit from older children (Fig. 2, c) but fails to discriminate between mite-sensitive and mite-insensitive subjects when asked by trained interviewers in the way it was asked in our study (Fig. 2, a). Possible reasons for this discrepancy include (1) the allergist questioned older children, whereas the whole group comprised chil-

dren of all ages; (2) the allergist invariably interviewed the child who experienced the change in symptoms as well as the parents; and (3) the allergist phrased the question so that instead of it being a general one, it would apply to situations that the child might remember. It is unlikely that bias was introduced by the allergist using questions that had not been standardized, since all questioning was completed before skin testing was commenced. Any

TABLE IV. Data for a subgroup of 95 asthmatic children 7 yr of age or older who were questioned by an allergist

Symptoms	Mite prick test				p value
	Positive		Negative		
	No.	%	No.	%	
Worse in bed					
Nose					
Yes	7	26.9	19	27.5	0.585
No	19	73.1	50	72.5	
Chest					
Yes	13	31.7	28	24.0	0.237
No	13	68.3	41	75.9	
Worse on awakening in A.M.					
Nose					
Yes	12	37.5	20	22.2	0.092
No	14	62.5	49	77.7	
Chest					
Yes	4	23.5	13	28.2	0.478
No	22	76.5	56	71.8	
Better outside					
Nose					
Yes	6	23.0	6	9.1	0.077
No	20	77.0	60	90.9	
Chest					
Yes	5	19.2	8	11.6	0.257
No	21	80.8	61	88.4	
Worse dusting					
Nose					
Yes	7	26.9	13	18.9	0.275
No	19	73.1	56	81.1	
Chest					
Yes	7	26.9	6	8.7	0.028
No	19	73.1	63	91.3	
Worse making beds					
Nose					
Yes	4	15.4	2	2.9	0.045
No	22	84.6	67	97.1	
Chest					
Yes	2	7.7	1	1.4	0.180
No	24	92.3	68	98.6	

influence of leading questions or suggestion, if present, would apply equally to those who were subsequently found to have positive or negative skin prick tests. The effect of suggestion seemed to be minimal, since the addition of the question about improvement when out of doors increased positive responses by 35% in those who were subsequently found to have a positive mite prick test and by only 13% in those with a negative test.

We are unable to substantiate the widely held belief that nocturnal wheezing is typical of asthmatics who are allergic to house-dust mites.^{9, 11, 13, 16} In a retrospective survey of 133 asthmatic children, where in-

formation was abstracted from the clinical notes, Warner and Price⁹ found nocturnal wheezing to be significantly more common in those with a positive than with a negative prick test to mite. They speculated that nocturnal symptoms predominate in the former because mites are found in largest number in mattress dust and bedding. Morrison-Smith¹¹ also reported a high proportion of nocturnal wheezing in mite-sensitive asthmatics but did not compare this with wheezing in a control group. In our prospective study of 530 asthmatic children we found that nocturnal aggravation of wheezing occurred in approximately half of both mite-positive and mite-negative

TABLE V. Association between skin prick tests and noticeable worsening of asthma during the colder months (top) and perennial asthma (bottom)

Asthma worse October to February*					
	Yes		No		
	No.	%	No.	%	
Mite the only positive	13	56.5	10	43.5	p = 0.037
Remainder	164	33.1	331	66.9	
Mite positive	44	37.3	74	62.7	p = 0.482
Mite negative	133	33.3	267	66.8	
Asthma equally bad all year*					
	Yes		No		
	No.	%	No.	%	
Mite positive	50	42	68	58	p = 0.523
Mite negative	185	46	215	54	
Mite or house dust positive	84	41	123	59	p = 0.090
Mite and house dust negative	151	49	160	51	

*Data missing in 12 cases.

groups and suspect that it is due more to diurnal variation in bronchial caliber or bronchial irritability than to exposure to larger mite numbers. Hetzel and Clark²⁴ found exaggeration of normal circadian rhythm in airway caliber in asthmatics, and Gervais et al.²⁵ and others have observed that less allergen is needed to induce bronchospasm at midnight than at any other time.

Furthermore, our subjects with a positive mite test did not have an increase in early-morning symptoms, a feature held by some to be characteristic of mite allergy.^{1, 12} Hargreave et al.²⁶ found that the early morning is the time of day when bronchial obstruction is greatest in most asthmatics. This feature is particularly marked in those whose bronchi are highly reactive to histamine, suggesting that worsening of asthma in the morning on awakening is a clinical indicator of increase in nonallergic bronchial responsiveness.

Our findings are in agreement with those of a previous study showing that asthmatic symptoms resulting from the mite component of house dust are likely to be more noticeable in the colder months than during the rest of the year.²⁷ This seasonal aggravation seems to depend more on circulation of mite allergen-rich dust particles by air currents, such as those generated by forced-air heating systems, than on mite numbers. There may be little relation between the number of intact mites in a sample of house dust and its mite allergen content²⁸; mite antigen PI is more plentiful in the smaller particles that become airborne, such as mite fecal pellets, than in the mites them-

selves.²³ In Vancouver, mites are more numerous in the warmer months¹⁹ but mite-induced symptoms are more prevalent in the heating season.²⁷ Although winter asthma occurred significantly more often in the small percentage of our patients whose sole positive skin test was to house-dust mite, no seasonal exacerbation was present in the great majority (83%) of those with a positive skin test to mite. These subjects had additional positive tests to other inhalant and pollen allergens that caused some of them to have their worst asthma in seasons other than winter. Consequently, the whole group with a positive prick test had a prevalence of winter asthma no different from those with a negative mite test.

A commonly held view is that mite-sensitive subjects typically have year-round symptoms.^{3, 9, 12, 13} This is also the opinion of Morrison-Smith,¹¹ who found, in an uncontrolled study of 100 mite-sensitive asthmatics, that 72 of them had noticed no seasonal difference in their asthma. Our results do not support the conclusion that a history of perennial symptoms can be used to distinguish mite-sensitive asthmatics from others, since we found that similar percentages of mite-insensitive and mite-sensitive subjects have no seasonal variation.

Features in the history were similar whether the patient was sensitive to mites, house dust, or both. The same proportions of mite- and house dust-sensitive asthmatics have increased symptoms during domestic activity, nocturnal aggravation is not characteristic of either of them, and neither has a typical

seasonal pattern. The diagnosis of house-dust allergy as well as mite allergy is of practical importance, since both of them require environmental control measures for treatment. These should include making the bedroom "dust-free."^{3,4}

In summary, mite-sensitive asthmatics cannot be distinguished by any characteristic seasonal pattern of symptoms, nor are nocturnal or early-morning aggravation of asthma useful features for their recognition. For epidemiologic purposes, a positive history of mite or house-dust allergy is one in which respiratory symptoms are worsened during some domestic activity such as sweeping, vacuuming, dusting, making the bed, or shaking out blankets. For clinical purposes, improvement in symptoms when the subject is out of doors is a useful additional indication of house-dust mite allergy.

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