

Peak expiration flow variations may reflect house-dust-mite exposure and patient reactivity

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Peak expiration flow records from patients allergic to house-dust mites (*Dermatophagoides* spp.) may show a characteristic variation from week to week due to the general life cycle of these mites in dwellings. This was demonstrated from the combined records of 10 patients recorded in their own homes, covering a period of 30 consecutive weeks and comprising 973 peak flows. The levels of house-dust mites were predicted from published data for floor-dust samples from Danish dwellings. Peak flow increased or decreased in accordance with weekly changes in the concentration of mites, rather than as an immediate reaction to the current concentration of live, active mites. A dose-response relation was demonstrated. This suggests that the patients' peak flow variations might be linked to molting in mites. As such, peak flow measurements have a potential as a tool for the specific diagnosis of, monitoring of, and research in asthma caused by domestic mites.

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The concentration of house-dust mites in dust samples from Danish dwellings shows a systematic variation over the year (1). The peak concentrations have been interpreted to represent the synchronized, active, and allergen-producing stages in the life cycle of the mites, with four annual generations. Similar peaks in the number of patients delivering dust samples for examination were observed to be 2–4 weeks delayed relative to the corresponding peaks in house-dust-mite concentrations. We tentatively suggested (1) that this clustering was caused by the patients' reaction to increased symptoms in weeks with an increased number of mites.

In the present work, we substantiate the association between the systematic variations in the concentration of active, allergen-producing mites and the disease activity of patients allergic to house-dust mites. As a measure of disease, we used daily peak flow readings performed by the patients themselves.

Material and methods

From all outpatients seen by one of us (J.K.) at Silkeborg County Hospital (Denmark) from May

1994 until May 1997, we selected retrospectively 15 patients with monosensitization (positive skin prick test and specific IgE) to house-dust mites (*Dermatophagoides pteronyssinus* and/or *D. farinae*). An increased exposure to house-dust mites had been documented by dust analysis, and the selected patients had performed extended periods of peak flow measurements twice daily. From these patients, we further selected those whose combined peak flow readings comprised an unabridged period of 1 year. From this material, the period 5 August to 11 March (weeks 32–08) was covered with 10 of the patients (Table 1). The first day of week 1 is 1 January (any year).

Mini-Wright peak flow meters were used, and the "best of three" measurements were recorded by the patients in their diaries. For each patient, the individual peak expiratory flow was formatted as percentage of the average morning or evening peak flow for the whole period the patient contributed. The peak flows calculated for each morning and each evening during the whole period are presented in Fig. 1 as moving averages for 7 days. Therefore, each plotted value of Fig. 1 represents an average of 14–70 single peak flow measurements. Notice that this is illustrated upside down in

Table 1 Survey of 10 patients with allergy to house-dust mites and documented increased exposure in their homes. Their peak flow records were combined to illustrate the characteristic, systematic variation in disease activity (Fig. 1)

Patient no.	1	2	4	6	9	10	11	12	13	15
Sex and age (years)	F9	M6	F24	M14	M17	F54	F26	F13	M14	F52
First day	22/11/94	23/11/94	16/01/97	29/02/96	16/09/96	05/11/96	05/08/96	08/01/97	13/12/96	01/09/95
Morning records	83	47	28	12	55	35	70	53	74	40
Morning average	270	298	438	333	457	414	462	462	465	205
Range	225–305	200–400	400–460	300–365	290–585	390–450	440–490	395–495	410–520	165–230
Evening records	83	30	28	12	56	35	70	48	74	40
Evening average	269	301	440	440	536	429	462	484	469	239
Range	220–300	215–375	410–470	410–470	415–610	390–440	440–480	430–500	400–570	195–265

Fig. 1, so that low peak flow readings (worsening of symptoms) correlate with increased concentration of mites. The material comprised 973 peak flow records.

Systematic variations in the concentration of house-dust mites in samples of floor dust from dwellings are given as weekly averages and were copied from previous data (1).

The two materials which we combine are records from dwellings of house-dust-mite allergic patients in Denmark who had sought medical help. Apart from this, the two materials have nothing in common, and were collected at different, non-superimposed periods of time.

Results

Qualitative covariation

It appeared that every predicted variation in the concentration levels of mites corresponded to a similarly shaped variation in the peak flow of patients the same week or slightly later (Fig. 1). Consequently, the patients appeared to react almost immediately to sudden increases in predicted concentrations of active mites. Temporary decreases in mite concentration between the stages in the development cycle of the mites caused a corresponding increase in peak flow in the patients. Thus, the reactions of the patients appeared to be almost immediate responses to the increase or decrease of new, active mites in the environment.

Quantitative covariation

A simple linear correlation between weekly mite concentrations and corresponding peak flow values was significant ($r = -0.53$ for $n = 30$; $P = 0.005$) and confirmed a direct correlation of the disease activity with the concentration of live, active mites.

The weekly variation in mite concentrations, however, seemed better correlated to changes in peak flow than mite concentration and peak flow as such. Thus, the variation of the parameters from one week to the next showed $r = -0.80$ for $n = 29$ for

the linear correlation between the weekly difference in mite concentration (x mites/0.1 g floor dust) and corresponding changes in the patients' percent peak expiration flow (y %), where $y = -0.0922x - 0.18987$). The line shown in Fig. 2 gives the size of order for the dose response in house-dust mites in relation to patients, and demonstrates increasing disease activity as a consequence of increasing concentration of mites ($P < 0.001$).

Discussion

Exposure parameters

In a recent survey, the following conclusion was drawn: "Indeed, it has proved difficult to obtain evidence supporting a simple dose-response relationship between exposure and symptoms" (2). As disease activity appears to be more clearly related

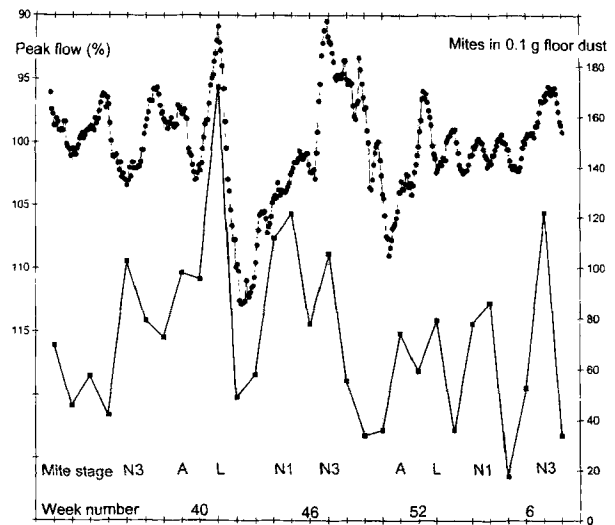


Fig. 1. Predicted level of house-dust mites (lower part of figure) is to be considered cause. Patient peak flows (upper part of figure) are responses expected to appear with no or some delay, and reflecting allergenic challenge to patient and individual patient's response to this challenge. Abbreviations used for consecutive active stages in life cycles of mites are as follows: L (larvae), N1 (protonymphs), N3 (tritonymphs), A (adults).

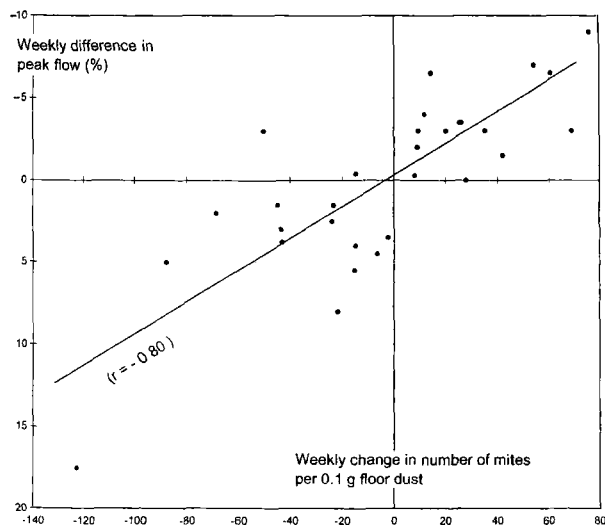


Fig. 2. Changes in predicted concentration of mites in 0.1 g of floor dust show covariance with corresponding changes observed in peak flows for 30 consecutive weeks in patients with asthma caused by house-dust mites. Same material as in Fig. 1.

to changes in mite exposure than to the actual dose (Fig. 2), the explanation may be that disease activity is not a direct consequence of the concentration of live, active mites, but merely related to what might be the flux of newly molted specimens into the pool of live, active mites.

Agents of disease

Fecal particles from mites are thought to be major sources of relevant allergen exposure in dwellings (2). A delayed response would be expected if fecal pellets were heavy, fast falling, stable, continuously produced, and accumulating particles from active mites were a significant source. The present observations, however, show immediate peak flow variations associated with the life cycle of the mite.

Molting fluid (from the partition between old and new cuticle) may be an alternative major allergen source. Its composition is unknown, but, due to its position, it is probably a whole-body eluate of the mite released into the environment at the very moment of the hatching of each stage in the life cycle of the mite.

Awareness

The line drawn from the regression analysis (Fig. 2) implies that patients exposed to stable or decreasing concentrations of house-dust mites experience no increase in disease activity. This may explain why house-dust-mite-allergic patients seek medical service in clusters (1), corresponding to those weeks in which the concentrations of live, active mites increase. Consequently, it should be possible, in the future, to forecast the annual periods of exacerbation and remission, as in other allergic diseases with periodic sources of allergens.

Peak flow measurements as specific tools

Peak flow recordings provide one of many options to determine the severity of disease. The patients' peak flow reactions to a vast number of variables are already known (3). With the present study, the exposure to house-dust mites is introduced as a new variable. The unique pattern of reactions due to the synchronization of stages in these mites provides further evidence of how house-dust mites cause disease. Discrimination among the individual patients' reactions to house-dust mites and other common mites in the indoor environment (*Glycyphagus domesticus* and *Tarsonemus* sp.) may be possible, since the systematic variation in their concentrations in samples of floor dust is different from that of the house-dust mites (1). The present data apply to Danish conditions. In other climates, the specific composition of mites and their population dynamics, as well as patient reactivity, could prove to be different.

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