

Storage mite allergy is common in a farming population

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Summary

The prevalence of storage mite allergy was investigated in an epidemiological study of respiratory symptoms in farmers on Gotland, an island in the Baltic Sea. A questionnaire concerning work-related and chronic symptoms from the airways and eyes was completed by 2578 farmers. A sample of 440 farmers subsequently underwent examination comprising skin-prick tests (animal danders, pollens, moulds and house dust mite), blood sampling for RAST against four storage mites (*Acarus siro*, *Lepidoglyphus destructor*, *Tyrophagus putrescentiae* and *Glycyphagus domesticus*) and total IgE analyses. Immediate onset hypersensitivity reactions in the airways and eyes were very common among active farmers on Gotland, the prevalence being as high as 40.0%. The prevalence of atopic allergy was 15.6%. Allergy to storage mites was diagnosed, from the case history and a positive RAST to at least one of the four storage mites, in fifty-two of 440 studied farmers (12%), corresponding to a calculated prevalence of storage mite allergy in the whole farming population of Gotland of 6.2%. The corresponding prevalence among farmers with hypersensitivity symptoms was 15.4% and among those with possibly IgE-mediated symptoms it was as high as 37.8%. The present study clearly demonstrates a high prevalence of allergy to storage mites among farmers with respiratory symptoms.

Introduction

Until recently farmer's lung, which was first described by Campbell [1], has been

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considered to be the predominant hypersensitivity condition in a farming population. However, farmers are exposed to many classical inhalant allergens and IgE-mediated allergy is a potential disorder that should not be neglected. In addition to pollens and animal danders, mites are potent allergens. Studies from Great Britain [2,3] and Finland [4] have demonstrated the presence of several species of storage mites in farming environments. Ingram *et al* [5] found that bronchial provocation tests supported the hypothesis that such mites could act as inhalant allergens. Later the presence of allergy to storage mites among farmers on the mainland of Scotland was reported [6]. Allergy to storage mites has also been observed in Sweden [7]. The true prevalence of this allergic condition, however, is still largely unknown.

The present study is part of a comprehensive investigation of hypersensitivity manifestations such as asthma and rhino-conjunctivitis due to allergy or hyperreactivity among farmers on Gotland, an island in the Baltic Sea (Fig. 1) with about 55 000 inhabitants many of which are engaged in small scale farming. The island is a demographically and geographically well-characterized area. The main interest was focused on the prevalence and symptoms of IgE-mediated storage mite allergy. In this paper we report the results of measurements of the total serum IgE concentration and of RAST tests against the mite species *Acarus siro*, *Lepidoglyphus destructor*, *Tyrophagus putrescentiae* and *Glycyphagus domesticus*.

Materials and methods

Subjects

A questionnaire, for self-administration, was distributed in November 1983 to all

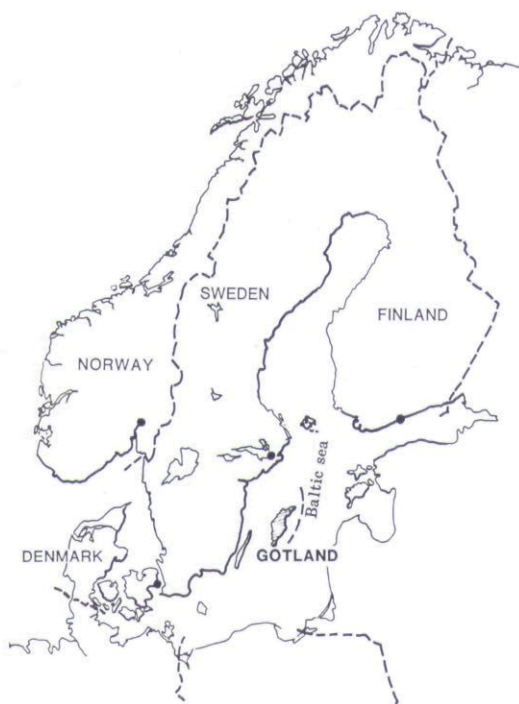


Fig. 1. The location of the island Gotland in the middle of the Baltic Sea.

farms on the island of Gotland organized by the Federation of Swedish Farmers. It contained fifty-nine questions concerning work-related and chronic symptoms from the respiratory tract and eyes, smoking habits and social working conditions. The questionnaire was completed by 2578 subjects aged 15–65 years, corresponding to 91% of the men and women of this age group mainly occupied with farming.

On the basis of the information from the questionnaires, all subjects were allocated to one of four symptom groups: (1) healthy subjects ($n=1462$); (2) 'mild hypersensitivity', those with immediate onset symptoms from either the lungs or the nose/eyes ($n=836$); (3) 'severe hypersensitivity', those with immediate onset symptoms from both the lungs and the nose/eyes ($n=87$) and (4) suspected allergic alveolitis ($n=194$). These symptom groups were only used in the calculations of prevalences and for selection of subjects for further studies. A random sample of 460 subjects of ages between 15 and 65 years (331 men and 109 women) with the same age distribution as the whole material, was selected from the four groups and invited to attend a thorough medical examination. Of these 460 farmers, 100 (one out of every fifteen farmers in category 1) were free from symptoms, 209 (one out of every four in category 2) had mild hypersensitivity, eighty-seven (every farmer in category 3) had severe hypersensitivity and sixty-four (one out of every three in category 4) had suspected allergic alveolitis, according to the classifications based on the questionnaire. Of the 460 invited farmers, 440 (95.7%) attended the examination which was performed in March/April 1984. The attendance in the four groups was group 1 93/100, group 2 199/209, group 3 86/87 and group 4 62/64.

The medical examination comprised a structured interview concerning allergic symptoms conducted by, and a physical examination performed by a physician with experience in allergic diseases, a skin-prick test (SPT), blood sampling for determination of IgE antibodies by RAST [8] and total IgE analyses, and measurements of peak expiratory flow (PEF).

The clinical investigation showed that the classification in four symptom groups based entirely on the information in the questionnaire was not absolutely correct. On the basis of the allergological interview and the questionnaire, all examined farmers

Table 1. Distribution of examined farmers between five symptom groups based on questionnaire and interview. The symptom groups were then subdivided into atopic and non-atopic on the basis of SPT to a panel of common inhalant allergens

Symptoms	No. of farmers	
	atopic	non-atopic
Immediate onset		
Asthma and/or cough	6	18
Asthma and/or cough and rhino-conjunctivitis	63	41
Rhino-conjunctivitis	67	117
Suspected allergic alveolitis	0	2
Asymptomatic	15	111

were finally allocated to five groups which were then further subdivided into atopic and non-atopic from the results of the SPT (Table 1). The subjects in each group were classified as atopic if they had at least two positive SPT reactions of grade ++ or one of grade +++ to the common allergens mentioned below. The classification of suspected allergic alveolitis required the occurrence of repeated attacks of characteristic symptoms such as recurrent febrile reactions with respiratory symptoms within the last 2 years. Blood samples were drawn from all subjects and the serum was stored at -20°C until analysed.

Allergen preparations

Commercial, aqueous extracts (Spectralgen and Pharmalgen, 10 000 BU, Pharmacia Diagnostics, Uppsala, Sweden) of animal danders (cat, dog, horse), pollens (birch tree, timothy grass, mugwort), mould (*Cladosporium*) and the house dust mite *Dermatophagoides pteronyssinus* (Dpt) were used. Aqueous extracts of cow dander and *Aspergillus* (Allergologisk Laboratorium A/S, Copenhagen, Denmark) were used at 1/20 w/v. An extract of wheat was prepared from washed wheat grains, 1/125 w/v in Coca's solution. This extract had been previously evaluated in patients with suspected allergy to wheat attending an allergy clinic.

Skin-prick test

A skin-prick test was performed on the volar side of the forearm with a tuberculin needle as described by Pepys [9]. SPT reactions were read after 15 min. A reaction similar to or larger than the weal occurring in response to a histamine solution (1 mg/ml) was regarded as strongly positive and designated +++ and weals half that size were designated ++ [10].

Radioallergosorbent test (RAST) and total serum IgE determinations

The radioallergosorbent test, RAST, was used essentially as previously described by Johansson *et al.* [11] to measure specific IgE antibodies in serum to the four storage mites. Fifty microlitres of undiluted serum was incubated with an allergen disc for 3 h at room temperature. After repeated washings, ^{125}I -labelled, immunosorbent purified anti-IgE of mixed D ϵ 1 and D ϵ 2 specificity [12], corresponding to approximately 50 000 counts per minute (cpm), was added for incubation at room temperature overnight. The washing procedure was repeated and the count rate of the discs was measured in a gamma scintillation counter (Rackgamma, LKB-Wallac, Stockholm). The cpm obtained were compared with those of the Phadebas RAST Reference System (Pharmacia Diagnostics, Uppsala, Sweden). The results were expressed in Phadebas RAST Units (PRU) per ml. All RAST reactions ≥ 0.20 PRU/ml were retested in duplicate and a positive result was defined as a value ≥ 0.35 PRU/ml. Allergen discs with *Acarus siro*, *Lepidoglyphus destructor* and *Tyrophagus putrescentiae* were obtained from MIAB (Allergo-Discs[®], MIAB, Knivsta, Uppsala, Sweden). Cultures of *Glycyphagus domesticus* were prepared by growing mites that had been manually selected under a microscope in a yeast medium. Extracts of raw material were made by incubation in 0.15 M NaCl containing 0.02% NaN_3 for some hours at room temperature. Allergen discs were prepared by coupling 0.5 ml of a 1/10 w/v extract of *G. domesticus*, and 0.05 ml of a mixture of a 1/1000 w/v extract of washed wheat grains and 1/10 w/v yeast representing the culture medium to 100 cyanogen-bromide-

activated paper discs [13], respectively. Discs with Dpt (Phadebas d1) were obtained from Pharmacia Diagnostics.

Serum total IgE levels were determined with the Phadebas IgE PRIST test (Pharmacia Diagnostics, Uppsala), following the recommendations of the manufacturer, and the results are given in kU/l.

Data analyses

The continuous variables for IgE and RAST are described as geometric means and 95% confidence limits for each group. Differences between groups were evaluated by a two-tailed *t*-test.

Figures for prevalences were calculated in the following way. Based on clinical investigation and/or results of SPT and RAST individuals among the 440 studied were identified as having a given symptom or a positive test to a given allergen. The distribution of these subjects in the four, original symptom groups was noted. Since it was known what fraction of all farmers on Gotland were included in these groups (e.g. for healthy 93/1462) the prevalence could be calculated.

Results

Table 1 shows the distribution of examined farmers, atopic and non-atopic, between the five final symptom groups. A diagnosis of suspected allergic alveolitis was made in only two subjects. Rhino-conjunctivitis alone (184/440 subjects, 41.8%) was the predominating symptom among the examined farmers.

The corresponding prevalences of these symptoms in the total farming population were calculated and are presented in Table 2. Immediate onset symptoms of hypersensitivity were present in a total of 40.0% of active farmers on Gotland and of atopic allergy in 15.6%. The prevalence of suspected allergic alveolitis was estimated to be 0.2%.

In general, atopic farmers had significantly elevated IgE levels as compared with non-atopic farmers with the same combination of symptoms (Table 3). The highest mean IgE level was found among atopic farmers with both rhino-conjunctivitis and lower respiratory tract symptoms.

A positive RAST (≥ 0.35 PRU/ml) to at least one of the four storage mite species (Table 4) was noted in 53/440 farmers (12.0%), of whom eighteen (34%) had specific IgE antibodies against all four species. Immediate type hypersensitivity symptoms occurred in fifty-two of the fifty-three RAST-positive farmers. Almost all RAST-positive farmers, fifty-one out of fifty-three, showed a positive response to

Table 2. Calculated prevalence of symptoms from airways and eyes among all farmers on Gotland based on questionnaire and interview

Symptoms	%
Any form of immediate onset hypersensitivity	40.0
Asthma and/or cough	3.5
Asthma and/or cough and rhinoconjunctivitis	10.6
Rhinoconjunctivitis	25.9
Suspected allergic alveolitis	0.2
Asymptomatic	59.8

Table 3. IgE levels in 440 farmers grouped according to symptoms

Symptoms	Atopic		Non-atopic	
	No.	IgE (kU/l)	No.	IgE (kU/l)
Asthma and/or cough	6	109.7** (8.3-1442)	18	20.9 (2.6-167)
Asthma and/or cough and rhinoconjunctivitis	63	132.3*** (11.0-1596)	41	27.9 (1.9-412)
Rhinoconjunctivitis	67	83.8*** (5.0-1394)	117	28.4 (2.0-406)
Suspected allergic alveolitis	0		2	17.5
Asymptomatic	15	59.6* (7.5-477)	111	26.8 (2.5-292)

* $P < 0.02$.** $P < 0.01$.*** $P < 0.001$.

IgE levels are geometric means and 95% confidence intervals for group distributions.

Table 4. Number of positive RAST (≥ 0.35 PRU/ml) responses to storage mites among farmers, and (in parentheses) the number in per cent of all positive tests

Subjects	At least one	<i>Lepidoglyphus destructor</i>	<i>Tyrophagus putrescentiae</i>	<i>Glycyphagus domesticus</i>	<i>Acarus siro</i>
440	53 (12.0%)	51 (96.2%)	30 (66.0%)	35 (56.6)	26 (49.1%)

L. destructor. In farmers with a positive RAST against storage mites, the highest PRU levels were found against this mite. Forty-five of the fifty-one patients who were RAST-positive to *L. destructor* (88.2%) were atopic and their mean level was 4.6 PRU/ml (95% conf. lim. 0.3-81.3 PRU/ml). Six farmers with a positive RAST to storage mites were negative to all the allergens in SPT. Their mean PRU level was 0.9 PRU/ml (0.1-6.2 PRU/ml). None of the 440 subjects had a positive RAST to the storage mite culture medium.

Thirty of fifty-three (56.6%) farmers positive to at least one of the four storage mites had a positive SPT to Dpt. Of all the studied farmers, 30/440 (6.8%) had both positive SPT and positive RAST to Dpt, and 37/440 (8.4%) were positive to Dpt in RAST. The corresponding figures for the prevalence among all farmers were 4.0% and 5.2%, respectively. In farmers with symptoms the prevalences were 10.0% and 11.5% and among those with possibly IgE-mediated allergy 24.7% and 28.3%, respectively.

More than one-third of the studied atopic farmers (39.7%) with bronchial asthma and/or cough in combination with rhino-conjunctivitis and 1/4 of the atopic farmers (26.9%) with rhino-conjunctivitis alone were RAST-positive to *L. destructor* (Table 5). The former group showed the highest mean PRU value to storage mites (8.3 PRU/ml (0.4-78.7 PRU/ml). The highest frequency of positive RAST tests to storage mites was found in the youngest age group (Table 6).

Table 5. Positive RAST (≥ 0.35 PRU/ml) to *Lepidoglyphus destructor* in 440 farmers grouped according to symptoms

Symptoms		Subject no.	Positive subject no.	PRU/ml
Asthma and/or cough	Atopic	6	1	9.1
	Non-atopic	—	—	—
Asthma and/or cough and rhino-conjunctivitis	Atopic	63	25	5.3 (0.4–78.7)
	Non-atopic	41	—	—
Rhino-conjunctivitis	Atopic	67	18	4.1 (0.2–88.9)
	Non-atopic	117	4	1.1 (0.1–10.5)
Suspected allergic alveolitis	Atopic	0	—	—
	Non-atopic	2	1	0.7
Asymptomatic	Atopic	15	1	0.4
	Non-atopic	111	—	—

RAST values are geometric means and 95% confidence limits.

Table 6. Prevalence of positive RAST (≥ 0.35 PRU/ml) to at least one species of storage mite in farmers according to age

Age (years)	No. of patients	Positive	
		No.	%
16–34	120	28	23.3
35–44	101	11	10.9
45–54	108	7	6.5
55–65	111	7	6.3

The calculated overall prevalence of storage mite allergy in the whole farming population on Gotland was 6.2%. In farmers with immediate onset airway hypersensitivity, the prevalence of a positive RAST to at least one of the four storage mites was 15.4%. In farmers with possibly IgE-mediated symptoms, i.e. those with atopic allergy and those with a positive RAST to storage mites but not being classified as atopic, the figure was more than twice as high, 37.8%.

Discussion

Several studies (14–16) have shown that pyroglyphid mites dominate the mite fauna of house dust, whereas storage mites are more infrequently found. Storage mites have also been reported to occur in very damp houses in Great Britain and in environments with pets and food stores [17]. In Great Britain, the Netherlands, Japan and several other countries, Dpt is the predominant indoor allergen, and in the Netherlands this mite species has been found to be the main allergen in 61.5% of patients with atopic allergy [14]. This is not the case in Sweden. In the greater Stockholm area on the east coast, clinically relevant Dpt allergy accounts for only 2% of allergic conditions encountered in clinical allergological practice (Sundin, B., pers. comm.). The most

likely explanation for the low frequency of allergy to Dpt in Sweden is the dry and warm indoor climate obtained by central heating during the winter season.

Storage mites have been found, sometimes in large amounts, in barns and stables not only in countries where Dpt is common in house dust but also in Nordic countries such as Finland [4]. The most common storage mite species found on the Orkney Islands were *Tyrophagus longior* and *Acarus siro/farris* [2], whereas *Tydeus* spp. and *Acarus siro* were the dominating species in Finland [4]. Storage mite allergy has been demonstrated in the farming environment in Finland [18], and also occurs in Sweden, as indicated by a study [7] of patients attending an allergy clinic.

The present investigation is one of the first extensive studies of the epidemiology of allergy to storage mites. The island of Gotland was chosen since it provided a geographically and demographically well-characterized area in which a large proportion of the adult population is engaged in small-scale farming. The climate is damp, probably favouring the development of mite and mould allergies. The examined farmers were selected from all (more than 91%) active farmers within the region on the basis of an allergological questionnaire. A higher proportion of symptomatic than asymptomatic farmers was investigated, thus allowing a more accurate calculation of the prevalence of storage mite allergy than if a random sample of predominantly asymptomatic farmers had been chosen [6]. Furthermore, the representativeness of the study group was excellent, since the number of drop outs was marginal (4.3%).

Our results clearly demonstrate that there is a high prevalence of allergy (6.2%), defined as a typical case history with immediate onset symptoms and a positive RAST, to storage mites among farmers on Gotland. Allergy to storage mites was most common among young farmers in the same way as atopic allergy in general is more common in young people. Whether the high prevalence is also valid for other parts of Sweden or other Nordic countries is not known. In our study SPT against storage mite extracts was not performed. However, since there often is a tendency to over-diagnosis of clinically relevant allergy when SPT is the only test procedure used, a prevalence figure based on symptoms and positive RAST tests is probably more accurate. It is not uncommon, for example, to find positive SPT combined with negative RAST and provocation challenge tests for inhalation allergens [11] and this seems to be the case also for storage mites [6]. The reason for the reversed findings for Dpt in this study is not fully understood.

Allergy to storage mites among farmers with symptoms of airway hypersensitivity was found to be very common (15.4%) and among those with immediate type, possibly IgE-mediated, hypersensitivity even more common (37.8%). Positive SPT and RAST to Dpt occurred in farmers with symptoms in 10.0%, and among those with possibly IgE-mediated allergy in 24.6%. The corresponding figures for RAST-positivity to Dpt were 11.5% and 28.3%, respectively. These figures may be compared to the low figure of 2% for allergy to Dpt among patients with suspected airway hypersensitivity attending the Allergy Clinic at one of the regional hospitals in Stockholm. The difference might be due to the type of patient population (strictly farming *vs* mainly urban), differences in climate (although both are on the east coast of Sweden) and social standard. Obviously, allergy to various types of mites is much more common in the farming than in the urban population. However, among farmers, considerably more were allergic to storage than to house dust mite.

Allergy to Dpt occurred in 56.6% of the farmers with allergy to storage mites. Statistical analyses of the results in this study as well as RAST analyses of sera from

other patient groups rule out any significant cross-reactivity between Dpt and the four storage mites tested. These results are in accordance with findings in Japan with use of the same storage mite allergen discs as in the present study (Miyamoto, T. and Haida N, pers. comm.) and also with the results of a study in England [17] using other storage mite allergen preparations.

Mite counts have been shown to reach a peak during October. Farmers with 'barn allergy', however, experience most of their symptoms during the winter months, when the cattle are housed and are being fed with hay and silage. All blood samples in this study were drawn in late March to early April. This is probably an optimal time both for a clinical evaluation of the case history and a serological diagnosis of allergy. Studies of the seasonal variations of the serum IgE-antibody levels to pollen allergens have shown that the highest concentrations are usually found within 2-3 months after the pollen season [19].

The prevalence of immediate onset symptoms of hypersensitivity (40.0%) and of atopic allergy (15.6%) among these farmers is astonishingly high, even when considerations is paid to the tendency to overestimate prevalence figures based on questionnaires. The most natural explanation of the high figures would be the vast number of allergens present in a farming environment. Among these storage mites allergens make a considerable contribution.

Contrary to recent findings in Finland [20], the occurrence of farmer's lung in our material was rare (calculated prevalence 0.2%). Studies in progress including precipitin analyses will show whether we have underestimated the prevalence on Gotland.

The prevalence of atopy, defined as at least two positive SPT reactions of grade ++ or one of grade +++ to the common allergens used was remarkably high in the farming population of our study (15.6%). The significantly ($P < 0.01$ or $P < 0.001$) elevated mean IgE levels in the atopic symptom groups support the correctness of the classification, since a high IgE value in a patient with respiratory hypersensitivity is an indication of atopic allergy [21,22]. Previous epidemiological studies of SPT reactivity in large populations [23-25] have mostly been performed on unselected groups of school children and young adults. The observed prevalences of one or two positive STP reactions have been in the order of 30-50%. It could be anticipated that some young atopic adults, by reason of symptoms, would opt for other occupations than farming at an early stage in life. Thus, our prevalence figure would be too low. This hypothesis is supported by our finding of a higher percentage of positive RAST to storage mites in young than in middle-aged and older farmers. In addition, results of SPT will depend on several factors other than individual sensitivity, such as the quality and potency of the allergen extracts used, as well as the age and sex of the subjects studied. Accordingly, comparisons of prevalence estimates from different studies are restricted by a number of factors that are difficult to control.

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