

Predominance of mite allergy over allergy to pollens and animal danders in a farming population

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Summary

The prevalence of IgE-mediated hypersensitivity to respiratory allergens, including *Lepidoglyphus destructor* (a storage mite) and *Dermatophagoides pteronyssinus*, was studied in a rural population of Gotland, a Swedish island in the Baltic Sea. A sample of 440 farmers underwent examination, comprising skin-prick tests (animal danders, pollens, moulds, house dust mite and wheat) and blood sampling for radio-allergo-sorbent tests (RAST) (birch, Timothy grass, dog, *D. pteronyssinus*, *Cladosporium* and *L. destructor*). The highest prevalence of positive skin-prick tests was noted for *D. pteronyssinus* (6.0%). Low prevalences of positive skin-prick tests, 0.7-2.7%, were found for pollens, animal danders and moulds. Among the tested allergens, *D. pteronyssinus* and *L. destructor* yielded the highest prevalences of positive RAST results, namely 5.2 and 6.8%, respectively. Most farmers with allergy to pollens and animal danders had symptoms both from the upper and lower airways and from the eyes. Among farmers with both asthma and rhinoconjunctivitis, the prevalence of positive RAST results for *L. destructor* and *D. pteronyssinus* were similar. The present study clearly demonstrates that mites are by far the most important allergens in the farming population on Gotland, whereas otherwise common allergens such as pollen and animal danders are clearly less significant.

Introduction

Allergic alveolitis ('farmer's lung') was first recognized among farmers by Campbell [1]. Apart from being susceptible to this condition, however, farmers are exposed to many classical inhalant allergens, such as pollens and animal danders, that may induce IgE-mediated allergy. In the past few years several species of storage mites have also been implicated as important respiratory allergens [2-5]. The prevalences of IgE-

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mediated hypersensitivity to respiratory allergens, including storage mites and *Dermatophagoides pteronyssinus*, in a rural population are still not completely known. In a recent comprehensive study of farmers on Gotland, a Swedish island in the Baltic Sea, the prevalence of allergy to storage mites was found to be 6.2% [6].

We report here the reactivities in skin-prick tests (SPT) and the results of radio-allergo-sorbent tests (RAST) against a number of pollens, animal danders, moulds and the house dust mite in farmers from Gotland.

Subjects and methods

Subjects

All farmers on Gotland who belonged to the Federation of Swedish Farmers (98%) received a questionnaire for self-administration in November 1983. It consisted of fifty-nine questions concerning work-related symptoms from the airways and eyes, smoking habits and the size and conditions of the farm. A total of 2578 farmers (91%), aged 15–65 years, mainly occupied with farming, answered the questionnaire.

From this group, 460 farmers were selected for detailed allergological studies, 440 of whom attended this examination. The investigation programme has been described in detail previously [6].

All 440 farmers were finally allocated to five symptom groups [asthma with or without cough ($n=24$), hereafter referred to as asthma; asthma and rhinoconjunctivitis ($n=104$); rhinoconjunctivitis alone ($n=184$); suspected allergic alveolitis ($n=2$) and asymptomatics ($n=126$)] on the basis of their answers to the questionnaire and of the results of the SPTs and the clinical investigation. Atopy was defined in each group either as at least two positive SPT reactions of grade ++ or one of grade +++ to the eleven common allergens mentioned below or a positive RAST (≥ 0.35 PRU/ml) to birch, Timothy grass, dog dander, *D. pteronyssinus* and *Cladosporium*. Asthma was considered to be present in persons with episodic shortness of breath, wheezing and difficulty in expiration. Allergic rhinoconjunctivitis (seasonal or perennial) was defined as episodic rhinorrhoea, usually associated with nasal stuffiness and sneezing and lacrimation, in response to known or suspected allergen(s). The diagnoses of asthma and rhinoconjunctivitis were made by a physician experienced in allergology on the basis of the case history and physical examination.

All prevalence figures (symptoms, SPT and RAST) pertaining to the whole population of farmers are based on the detailed investigations of the 440 farmers attending the examination.

Skin-prick tests

Skin-prick tests were made by an experienced nurse on the volar aspect of the forearm with a tuberculin needle as described by Pepys [7]. The results were read after 15 min. Weals the size of, or larger than, the weal occurring in response to histamine solution (1 mg/ml) were regarded as strongly positive and designated +++. Weals half that size were designated ++ [8] and considered as positive SPT. Subjects showing a positive prick test to the diluent were deleted from the study (4/440).

Radio-allergo-sorbent test

Specific IgE antibodies in serum determined by RAST as described by Johansson *et al.* [9], using an immunosorbent ^{125}I -labelled anti-IgE (Phadebas® RAST, Pharmacia

Diagnostics AB, Uppsala, Sweden) of mixed D ϵ 1 and D ϵ 2 specificity [10], following the instructions of the manufacturer.

The count rates obtained were compared with those of the Phadebas® RAST Reference System (Pharmacia Diagnostics AB, Uppsala, Sweden). The results are expressed in Phadebas RAST units (PRU) per ml. All RAST values ≥ 0.20 PRU/ml were re-tested in duplicate and a positive result was defined as a value ≥ 0.35 PRU/ml. Allergen discs with birch tree (t3), Timothy grass (g6), dog dander (e2), *D. pteronyssinus* (d1), *Cladosporium* (m2) and *Lepidoglyphus destructor* (d71) were obtained from Pharmacia Diagnostics AB, Uppsala, Sweden.

Allergen preparations

Commercial, aqueous extracts (Spectralgen and Pharmalgen, 10 000 BU, Pharmacia Diagnostics AB, Uppsala, Sweden) of pollens (birch tree, Timothy grass, mugwort), animal dander (cat, dog, horse), moulds (*Cladosporium*, *Aspergillus*) and the house dust mite *D. pteronyssinus* 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, 1/25 w/v in Coca's solution. This extract had been previously evaluated in patients with suspected allergy to wheat attending an allergy clinic. *Lepidoglyphus destructor* extract of high quality was not available at the time of the study. Many farmers without a history of allergy to cow dander showed positive SPT reactions to the cow dander extract. In the final analysis, except in calculations of atopy prevalences, the results for cow dander were not included because of suspected non-specific reactions (a remarkably high prevalence, 9.9%, and a high percentage, 80%, of clinically irrelevant positive SPTs). The results for wheat were included in the calculations of atopy prevalences and used as a control for the storage mite culture medium.

Calculation of prevalence figures

Prevalence figures were calculated as follows. Based on clinical investigation and/or results of SPT and RAST, subjects among the 440 studied were identified as having a given symptom or a positive test to a given allergen. The distribution of these subjects among the five 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 persons 93/1462), the prevalence could be calculated.

Results

Population characteristics

The results of the questionnaire were based on 2578 subjects, 71% of whom were men, 29% women. The male and female subjects were of the same mean age, 43 years. The age distribution is shown in Table 1.

A total of 64.3% of the farmers had never smoked, 13.2% were ex-smokers and 22.5% were current smokers. The smoking habits did not differ between asymptomatic subjects and subjects with airway and eye symptoms. Moreover, the proportion of present and former smokers was similar in farmers with asthma alone (43.7%), asthma and rhinoconjunctivitis (37.4%) and rhinoconjunctivitis (37.8%), respectively. Most

Table 1. Age distribution of the 2578 farmers in the survey group

	Age (years)					Total
	16-25	26-35	36-45	46-55	56-65	
<i>n</i>	303	397	703	648	527	2578
%	11.8	15.4	27.3	25.1	20.4	100

farmers (73.3%) were working full-time (≥ 40 hr weekly) but 23.5% were working part-time (30-40 hr weekly). More than 70% of the farmers had been occupied with small-scale farming for more than 10 years. Nearly all (more than 90%) could be characterized as general farm workers and, thus, were involved in cattle feeding and handling of hay and straw. Almost two-thirds of the farmers took part in threshing.

Atopy was calculated to be present in 18.6% of all 2578 farmers studied on Gotland. The corresponding proportions among symptomatic and asymptomatic farmers were 28.4% and 11.5%, respectively. The overall prevalence of atopic respiratory allergy among farmers on Gotland was 15.9% (1.0% had asthma, 5.9% asthma and rhinoconjunctivitis, and 9.0% rhinoconjunctivitis only). Excluding the results for cow dander in the calculations of the overall prevalence of atopy, the corresponding figure was 14.0%.

Skin-prick test and RAST results

Generally the prevalence of positive case histories were markedly lower than the corresponding figures for positive SPTs (10 000 BU). Low proportions of positive SPTs were found for pollens (1.5-2.7) and very low ones for the mould *Cladosporium* (0.7%) (Table 2). Only a few farmers (1.6-1.7%) exhibited positive skin reactions to cat, dog or horse dander. The highest proportion of positive SPTs, 6.0%, was found for *D. pteronyssinus*, also when compared with the prevalence of positive SPT reactions to various categories of allergens (Table 3).

Table 2. Prevalences of positive SPT and RAST against various common allergens among farmers on Gotland

Allergen	SPT(%)	RAST(%)
Birch	2.7	1.7
Timothy	1.5	3.9
Mugwort	2.0	n.d.*
Dog	1.7	0.9
Cat	1.6	n.d.
Horse	1.6	n.d.
<i>D. pteronyssinus</i>	6.0	5.2
<i>Cladosporium</i>	0.7	0.1
<i>Aspergillus</i>	2.2	n.d.
<i>L. destructor</i>	n.d.	6.8

*n.d. = not determined.

Table 3. The percentage numbers of farmers on Gotland with positive SPT reactions to various categories of allergens

Allergen	%
Pollens	4.4
Animal danders	2.7
Moulds	2.2
<i>D. pteronyssinus</i>	6.0

As a rule, the prevalence of positive RAST were slightly lower than those of positive corresponding SPT results (Table 2). Notably, Timothy was the only allergen that gave a higher frequency of positive RAST than of SPTs (3.9 and 1.5%, respectively), which indicates that the Timothy extract might have been of poor quality. The prevalence of positive RAST against *D. pteronyssinus* (5.2%) and *L. destructor* (6.8%) were the highest among the tested allergens. Six farmers with a positive RAST to storage mites were negative to all allergens in SPT. Their mean PRU level was 0.9 PRU/ml.

The occurrence of positive SPTs and IgE antibodies against various allergens among asymptomatic farmers and farmers with asthma, asthma and rhinoconjunctivitis, and rhinoconjunctivitis alone is seen in Table 4. Most farmers with allergy to pollens (birch, Timothy and mugwort) and animal danders (dog, horse, cat) had both asthma and rhinoconjunctivitis. *Dermatophagoides pteronyssinus* and *L. destructor* were the most common single allergens. Farmers with a positive SPT and/or RAST against *D. pteronyssinus* and *L. destructor* were not equally distributed between the

Table 4. The prevalence of positive SPT and RAST in asymptomatic and symptomatic farmers (%)

Allergen		Asthma (n=90)	Asthma and rhinoconjunctivitis (n=273)	Rhinoconjunctivitis (n=668)	Asymptomatic (n=1541)
Birch	SPT	—	9.2	4.3	1.0
	RAST	—	5.0	2.2	1.0
Timothy	SPT	—	5.0	1.4	1.0
	RAST	4.6	11.8	3.8	2.4
Mugwort	SPT	—	4.2	3.6	1.0
Dog	SPT	4.6	6.9	0.6	1.0
	RAST	4.6	6.9	0.2	—
Horse	SPT	—	3.4	—	2.0
Cat	SPT	—	6.9	0.9	1.0
<i>D. pteronyssinus</i>	SPT	8.0	16.4	10.9	2.0
	RAST	8.0	15.8	10.2	1.1
<i>Cladosporium</i>	SPT	—	—	0.2	1.0
	RAST	—	—	0.2	—
<i>Aspergillus</i>	SPT	—	—	1.3	3.1
<i>L. destructor</i>	RAST	4.4	20.6	14.2	1.0

three symptomatic groups (asthma, asthma and rhinoconjunctivitis and rhinoconjunctivitis alone), the prevalence of positive tests being higher among farmers with both asthma and rhinoconjunctivitis.

Discussion

In several investigations conducted during recent years a high prevalence of allergy to storage mites has been established among farmers with hypersensitivity reactions in the airways and eyes [4,6,11]. On theoretical grounds, farmers should also show high rates of skin sensitization to pollens, animal danders and moulds, since they are highly exposed to such common potent allergens daily. However, exposure to large quantities of allergens might instead render farmers tolerant, whereas low doses of the same allergen cause sensitization in an urban population. Furthermore, air pollution leading to slight damage to the airway mucosa can increase the risk of both allergic sensitization and the development of bronchial hyperreactivity in subjects living in industrial areas. Differences in smoking habits [12] between farmers (22.5%) and the general Swedish population (35% according to current statistics from the Swedish Tobacco Company, 1985), might also partly explain a lower prevalence of allergy to pollens and animal danders among farmers.

The reason for the low prevalence of 'hay-fever' and allergy to animal dander reported in this study, thus, remains speculative. Since the age distribution was skewed towards middle age, and the proportion of atopics was, as expected, higher among the young participants, it could be argued that some young farmers had by reason of symptoms changed their occupation at an early stage. Alternatively, the rainy and windy climate of the island may diminish the amount of pollen carried in the air.

It is obvious that in all studies the quantity and quality of the extracts used in SPT will influence the size of the weal and, thus, the observed prevalence figures of positive SPT and, consequently, also of atopy.

Furthermore, different criteria for SPT positivity and atopy have been adopted in most studies. In addition, the prevalence of positive tests is dependent on sex and age. Skin-test reactions have been reported to be most frequent in young adults and decline rapidly in subjects older than 50 years [13].

In a study similar to ours, Cuthbert [14] found a prevalence of atopy of 21.5% in farmers on the main island of Orkney. Atopy was defined as one or more positive skin-test reactions to a common allergen. Weals over 2 mm in diameter in the presence of a negative control test were regarded as positive. The reported prevalence of respiratory allergy in the Orcadian farming population was 16.9%. The corresponding figures for the prevalences of atopy and atopy allergy among farmers on Gotland were similar (18.6% and 15.9%, respectively). The reported prevalence of atopy among farmers on Gotland is probably somewhat overestimated, since the results of the cow dander SPTs were included in the calculations. Haathela & Jokela [15] observed a positive SPT in 50% of Finnish conscripts. The skin-test reaction was regarded as positive if the diameter of the weal produced was 3 mm or more.

Moreover, farmers obviously differ from other studied groups with respect to which allergens seem important. Allergy to pollens was remarkably rare, while allergy to mites, especially storage mites [6], was common. These findings are in good agreement with the results of Cuthbert [14].

Among farmers on Gotland with immediate-type hypersensitivity symptoms from

the airways and eyes, the predominance of positive SPTs to *D. pteronyssinus* was striking.

The prevalence of positive RAST results to *D. pteronyssinus* and storage mites in the whole population of farmers were quite similar, 5.2% and 6.8%, respectively [16]. On the basis of their acarological relationship, one might expect that these mite species would cross-react. However, recent data clearly demonstrate a lack of cross-reactivity [17]. The similar prevalences of allergy to various mites, thus, would rather reflect the multiple species that are present in the same environment. Furthermore, in farmers with both asthma and rhinoconjunctivitis, the prevalence of positive RAST results to *L. destructor* and *D. pteronyssinus* was indicated to be higher than in the other symptom groups. Thus, from a clinical and epidemiological point of view, mites are by far most important allergens of those tested in a farming population, whereas otherwise common allergens such as pollens and animal danders are clearly less significant.

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