

The prevalence of allergy in Danish farmers

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Sensitization to work-related and other common inhalation allergens was studied in 187 farmers by means of SPT and RAST. A positive RAST to house dust mites occurred in 6.4% and to storage mites in 5.3% of farmers. Sensitization to grain, pollen and animal dander was less frequent and a positive RAST to moulds was not found. There was a very strong association between a positive RAST to house dust mites and storage mites (odds ratio 173.6). Smoking seemed to be a risk factor for sensitization to mites, pollen, grain, and animal dander. Smokers who had lived in damp dwellings had a significantly increased risk of sensitization to mites (odds ratio 6.2-12.6), whereas this was not so with non-smokers (odds ratio 0.9-2.0).

Key words: agriculture; allergy; mites; smoking.

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Farmers are exposed to a variety of allergens during work, and sensitization to some of the allergens occurs regularly. The predominating allergy in Swedish (5), Finnish (15), Scottish (4), English (2), and Danish (10) farmers is allergy to storage mites, whereas allergy to pollen, animal dander and moulds is more rare. Some earlier studies (5, 10) have used stratified sampling technique and this may distort the relationship between sensitization to allergens and possible risk factors for sensitization. The aim of this investigation was to study sensitization to work-related and other common allergens in a random sample of farmers.

METHODS

The study population consisted of 187 farmers (127 pig farmers and 60 dairy farmers) who were a random sample of farmers with medium-sized to large farms. They were not a sample of all farmers as this would include a proportion of elderly farmers, part-time farmers with limited exposure, and farmers with very small farms. Every year a number of these farmers leave

their occupation whereas the farmers in the study population are more likely to continue. Lung function characteristics and full details of personal characteristics have been published elsewhere (9).

Allergological evaluation was made by means of a structured interview which also contained questions on environmental variables and family history.

Skin prick test (SPT) was performed with the Phazet needle (Pharmacia, Uppsala, Sweden) for the following allergens: pollens of timothy (*Phleum pratense*), mugwort (*Artemisia vulgaris*), and birch (*Betula verrucosa*). Animal dander of cat, dog, and horse. House dust mites (*Dermatophagoides pteronyssinus* and *Dermatophagoides farinae*). Moulds (*Alternaria alternata* and *Cladosporium herbarum*). These allergens had a strength equivalent to 100,000 Biological Units (BU)/ml. Additional SPT were performed with the Prick-lancet needle (Dome/Hollister-Stier, UK) with the following allergens: storage mites obtained from Diepdiagnost (Diephuis, Groningen, The Netherlands) in a strength of 1.0% w/v reconstituted to 0.1% w/v in Pharmacia albumin

Table 1

Personal characteristics of 127 pig farmers and 60 diary farmers (numbers in percentages)

	Pig farmers	Diary farmers	Significance
Mean age (years)	42.7	43.2	0.77
Current smokers	20	32	0.07
Ex-smokers	19	10	0.10
Atopic relatives	42	38	0.21
Work-related respiratory symptoms	39	5	0.00
Mould growth in dwelling	19	22	0.65
Former damp dwelling	39	40	0.85
Asthma	5	3	0.99
Asthma and rhinitis	2	3	0.77
Rhinitis	3	3	0.99
Asthma and/or rhinitis	9	10	0.99

diluent (Pharmacia, Uppsala, Sweden). Mite species were *Acarus siro*, *Tyrophagus putrescentiae*, and *Lepidoglyphus destructor*. Soluprick allergen solutions (ALK, Copenhagen, Denmark) were used at a strength of 5 % w/v for the following allergens: rye (*Secale secale*), oat (*Avena sativa*), wheat (*Triticum sativum*), barley (*Hordeum sativum*), cow and swine dander, and *Aspergillus fumigatus*. In addition, an extract of soya bean was included. Specific IgE was measured with the radio allergo sorbent test, RAST (Pharmacia, Uppsala, Sweden). Total serum IgE was measured with the Phadebas radio immuno sorbent test, PRIST (Pharmacia, Uppsala, Sweden). All persons had RAST for mites, grain, moulds, cow and swine dander and whenever a SPT was positive.

Statistics

Frequencies of discrete variables were compared with chi-square test. Association between dichotome variables in two-way tables was assessed by the odds ratio (3) which is an estimation of the relative risk. Confidence limit for odds ratios was according to (13) and stratified analysis (12) was used to to evaluate confounding effects between variables. Analysis of variance was used to evaluate IgE. Because of non-

Table 2

Number and percentage of positive SPT (wheal ≥ 2 mm) and RAST (≥ 0.35 PRU/l) in 187 farmers

Allergen	SPT (%)	RAST (%)
Pollen		
timothy	6 (3.2)	2 (1.1)
mugwort	7 (3.7)	3 (1.6)
birch	6 (3.2)	1 (0.5)
Animals		
horse	3 (1.6)	1 (0.5)
dog	4 (2.1)	0
cat	2 (1.1)	0
cow	6 (3.2)	2 (1.1)
swine	3 (1.6)	2 (1.1)
House dust mites		
<i>D. pteronyssinus</i>	13 (7.0)	11 (5.9)
<i>D. farinae</i>	15 (8.0)	7 (3.7)
Storage mites		
<i>A. siro</i>	15 (8.0)	2 (1.1)
<i>T. putrescentiae</i>	13 (7.0)	3 (1.6)
<i>L. destructor</i>	12 (6.4)	6 (3.2)
Moulds		
<i>A. alternata</i>	2 (1.1)	0
<i>C. herbarum</i>	3 (1.6)	0
<i>A. fumigatus</i>	3 (1.6)	0
Grain		
rye	3 (1.6)	6 (3.2)
oat	7 (3.7)	10 (5.3)
wheat	2 (1.1)	5 (2.7)
barley	5 (2.7)	5 (2.7)
soy bean	2 (1.1)	6 (3.2)

normal distribution of IgE, logarithmic transformation was used.

RESULTS

Personal characteristics are given in Table 1. Mean age was 42.8 years. Twelve people (6 %) had a clinical diagnosis of asthma. Pig and dairy farmers did not differ significantly as to mean age, frequency of atopic relatives, and housing conditions (evidence of damp housing). There were more smokers among dairy farmers and more ex-smokers among pig farmers, although the difference was not statistically significant (Table 1).

The results of SPT and RAST are shown in Table 2. The most prevalent SPT was towards mites, *D. pteronyssinus* (7.0 %), *D. farinae* (8.0 %), *A. siro* (8.0 %), *T. putrescentiae* (7.0 %), and *L. destructor* (6.4 %). A positive SPT to

Table 3

Frequency of sensitization to house dust mites (HDM), storage mites (SM), and grain (rye, oat, wheat, barley) in pig farmers and dairy farmers and significance of difference between groups

		Pig farmers (n = 127) (%)	Dairy farmers (n = 60) (%)	Significance
Cow	SPT	4 (3)	3 (5)	0.80
	RAST	1 (1)	1 (2)	0.99
Swine	SPT	4 (3)	0	0.42
	RAST	1 (1)	1 (2)	0.99
HDM	SPT	9 (7)	9 (15)	0.15
	RAST	7 (6)	5 (8)	0.66
SM	SPT	15 (12)	8 (13)	0.94
	RAST	6 (5)	4 (7)	0.81
Grain	SPT	4 (3)	5 (8)	0.24
	RAST	6 (4)	5 (8)	0.51

pollen (3.2%–3.7%) and to grain species (1.1%–3.7%) had a lower prevalence than for mites. The most prevalent positive SPT to animal dander was cow (3.2%). The most prevalent positive RAST was towards mites, *D. pteronyssinus* (5.9%) and *L. destructor* (3.2%). A positive RAST towards grain species (2.7%–

5.3%) occurred nearly as frequently as towards mites. A positive RAST to pollen was rare (0.5%–1.6%) and no positive RAST to moulds was found. Most RAST values were, however, low, only for mites and grain species were there high RAST values. Positive SPT and RAST to storage mite (SM) was found in 12.3% and 5.3% of farmers, respectively. Positive SPT and RAST to house dust mite (HDM) was found in 9.6% and 6.4%, and to any grain species in 4.8% and 5.9% of all farmers, respectively. Pig farmers and dairy farmers did not differ significantly with respect to sensitization to HDM, SM and grain (Table 3). There was no significant difference between pig and dairy farmers in the frequency of a clinical diagnosis of asthma and rhinitis (Table 1). Because of the similarity between pig and dairy farmers they were treated as one group in further analysis of sensitization to mites and grain. The geometric mean of serum total IgE was 30.3 kU/l. Geometric mean in pig farmers (26.9 kU/l) and dairy farmers (38.0 kU/l) was not significantly different ($P = 0.09$). Geometric mean in non-smokers (23.2 kU/l) and smokers (54.1 kU/l) was significantly different ($P < 0.01$). Two-way analysis showed that both smoking and type of farming influenced log (IgE) but the amount of variation explained was only 8% of the total variation in log (IgE).

Table 4

Odds ratios and 95% confidence intervals for odds ratios for association between a positive SPT to house dust mites (HDM), storage mites (SM), pollen, grain, current smoking, and positive family history of atopy

	HDM (n = 18)	Pollen (n = 12)	Grain (n = 9)	Smoking (n = 44)	Atopy (n = 76)
SM (n = 23)	100.6 39.4–257	21.3 7.7–58.8	11.1 3.5–35.7	2.4 0.9–5.8	1.4 0.6–3.4
HDM (n = 18)		13.6 4.8–38.7	15.9 5.1–49.3	2.3 0.8–6.2	2.0 0.7–5.1
Pollen (n = 12)			9.4 2.6–34.6	5.2 1.7–15.8	3.1 0.9–10.0
Grain (n = 9)				4.5 1.3–15.8	0.7 0.2–3.0
Smoking (n = 44)					1.3 0.7–2.6

Table 5

Odds ratios and 95 % confidence intervals for odds ratios for association between a positive RAST to house dust mites (HDM), storage mites (SM), pollen, grain, current smoking, and positive family history of atopy

	HDM (n = 12)	Pollen (n = 4)	Grain (n = 11)	Smoking (n = 44)	Atopy (n = 76)
SM (n = 10)	173.6 61.3-488	21.9 4.8-99.1	28.5 9.7-83.9	3.5 1.1-12.0	1.5 0.4-5.2
HDM (n = 12)		17.3 13.6-82.2	12.0 3.7-38.6	3.6 1.2-11.1	1.5 0.4-5.3
Pollen (n = 4)			19.3.4 4.2-89.8	3.4 0.7-22.1	P > 0.90
Grain (n = 11)				2.9 0.8-9.7	1.2 0.4-4.2
Smoking (n = 44)					1.3 0.7-2.6

Association between variables

The association between sensitization to various allergens, smoking and a family history of atopy is given in Table 4 (SPT) and Table 5 (RAST). The most prominent feature of Table 4 was the strong association between positive SPT to HDM and SM (odds ratio 100.6). This meant that 15/23 (65 %) people with a positive SPT to SM also had a positive SPT to HDM, and that 15/18 (83 %) with a positive SPT to HDM also

had a positive SPT to SM. The associations between other positive SPT were also significant, but absolute numbers were small and the odds ratios had wide confidence intervals. The strength of the associations meant that 30 %-60 % had positive SPT to an allergen given another positive SPT. A positive family history of atopy was not significantly associated with a positive SPT. A positive SPT to pollen (odds ratio 5.2), grain species (odds ratio 4.5) and cow/swine dander (odds ratio 6.0) was significantly associated with smoking.

Table 6

Number of persons with a positive RAST to storage mites and grain in farmers with a clinical diagnosis of asthma and rhinitis and work-related respiratory symptoms

	Positive RAST to storage mites (n = 10)	Positive RAST to grain (n = 11)
Asthma (n = 8)	3	1
Asthma + rhinitis (n = 4)	1	1
Rhinitis (n = 6)	2	1
Work related respiratory symptoms		
in shed (n = 53)	3	3
when handling grain (n = 32)	3	2
when handling hay/straw (n = 22)	2	0

A positive RAST to SM was very strongly associated with a positive RAST to HDM (odds ratio 173.0) (Table 5). This meant that 8/10 (80 %) with a positive SM RAST also had a positive HDM RAST and that 8/12 (75 %) with a positive HDM RAST had a positive SM RAST. Most of the positive RAST to allergens were positively associated but none of the positive RAST was significantly associated with a family history of atopy. A positive RAST to SM (odds ratio 3.5) and HDM (odds ratio 3.6) was significantly associated with smoking. The association between smoking and a positive RAST to other allergens was positive (odds ratio 2.9–3.4) but was not significant.

The relationship between work-related allergies (a positive RAST to storage mites and/or grain) and work-related respiratory symptoms was not strong (Table 6). Six of 10 with a positive SM RAST had a clinical diagnosis of asthma and/or rhinitis and only three of these had respiratory symptoms during work in the animal shed or during work with grain. Two with a positive SM RAST had respiratory symptoms when handling hay or straw. Two with a positive RAST to grain had respiratory symptoms when handling grain.

Relationship between mite allergy and housing conditions

A positive HDM and SM RAST was not associated with mould growth in present dwelling or formerly living in a damp dwelling (Table 7),

Table 7

Relationship between a positive RAST to house dust mites, (HDM) storage mites (SM) and indicators of damp housing conditions. Figures are odds ratios and 95 % confidence intervals for odds ratios

	Mould growth in present dwelling (n = 37)	Damp housing in the past (n = 73)
Positive RAST to HDM (n = 12)	0.3 0.1–2.5	1.1 0.4–3.7
Positive RAST to SM (n = 10)	0.4 0.1–3.3	0.6 0.2–2.2

but was significantly associated with smoking (Table 5). Smoking was associated with former damp housing conditions (odds ratio 2.3) but not with mould growth in the present dwelling (odds ratio 0.9). The relationship between positive SPT and RAST to HDM, and SM and smoking was therefore examined in two-way tables with stratification for former damp housing, but this only marginally changed the odds ratios. When the relationship between sensitization to HDM and SM and smoking was studied in two-way tables with stratification for former damp housing a consistent pattern was found (Table 8). Smoking was not a risk factor for sensitization to HDM and SM in farmers who had not formerly lived in a damp dwelling. In farmers who had formerly lived in a damp dwelling smoking was a risk factor for sensitization to both HDM and SM (odds ratios 6.2–12.6).

DISCUSSION

The results from this cross-sectional study of a random sample of farmers with medium-sized and large farms confirm the results of previous cross-sectional studies (15) and those (5, 10) where stratified sampling was used. In all studies sensitization to mites has been the most prevalent type in farmers, whereas sensitization

Table 8

Relationship between a positive SPT, and RAST for mites and smoking with stratification for damp housing conditions in the past. Figures are odds ratios and 95 % confidence intervals for odds ratios. The significance of the χ^2 -test is indicated where an odds ratio could not be estimated

	No damp housing in the past (n = 114)	Damp housing in the past (n = 73)
Positive SPT to HDM/smoking	0.3 0.2–4.5	12.6 2.0–78.0
Positive RAST to HDM/smoking	2.0 0.4–10.7	9.6 1.4–65.0
Positive SPT to SM/smoking	1.7 0.5–5.9	6.2 1.3–29.0
Positive RAST to SM/smoking	2.0 0.4–10.7	> 7.0 P = 0.01

to pollen, animal dander and moulds was less prevalent. The one exception was a positive SPT to cow dander which was found in 14 % of Finnish farmers, 1 % of schoolteachers (14) and 10 % of Swedish farmers (5). The allergen extracts in (5, 14) were the same as used in this study. In the Swedish study (5) the results of SPT to cow dander were discarded because they were thought to represent non-specific reactions. There is no obvious explanation for the different sensitization rates to cow dander. The Danish farmers were just as exposed as the Finnish because they had large farms. As in previous studies there was a concentration of people with a positive RAST to SM in those with asthma or rhinitis, whereas the prevalence was low in those with no asthma, rhinitis and respiratory symptoms. There were, however, many more with work-related respiratory symptoms than with a clinical diagnosis of asthma, and these symptoms were not associated with a positive SM RAST.

A positive RAST to grain was found in two people with asthma and in two with respiratory symptoms when handling grain. An English study (2) showed a positive SPT to SM in 52 % of farmers with respiratory symptoms when handling grain; however, 22 % of asymptomatic farmers also had a positive SPT to SM. The majority of farmers (90 %–95 %) in this study with work-related respiratory symptoms had no positive SM RAST and only 6/18 (33 %) with a clinical diagnosis of asthma and/or rhinitis had a positive SM RAST. This suggests that in some farmers a positive RAST to storage mites may reflect exposure and is not associated with clinical disease or respiratory symptoms. In farmers with asthma and a positive SM RAST, bronchial challenge tests with storage mites does provoke acute asthma (6, 8). No challenge test of this subgroup (4 farmers) was performed in this study.

House dust mites and storage mites are not allergenically related (1, 7), so the very strong association between sensitization to the two mite genera must be caused by a common individual or environmental factor. A positive family history of atopy was not significantly related to a positive SPT or RAST to mites but sensitization to mites, pollen and grain was associated, so a family his-

tory of atopy may not be an appropriate index of atopic predisposition in the individual. Atopic predisposition seems to explain some of the strong association between sensitization to HDM and SM. A common environmental factor is damp housing conditions, which has been demonstrated relevant in asthmatic patients (11, 17) and farmers (10). There was no direct relationship between living in a dwelling with visible mould growth and SM sensitization, and the association between former damp housing conditions and SM sensitization was indirect. Smoking was a significant risk factor when the farmers had lived in a dwelling they recalled as damp. This association was strong with odds ratios 6.2–12.6 and was unlikely to be caused by any bias. The majority of farmers with a positive SM RAST, however, could not recall living in a damp dwelling. Smoking has been reported a risk factor for sensitization to certain allergens, such as green coffee beans and isphagula (17), and living in damp housing has been reported (16) associated with SM sensitization, but an interaction between two risk factors for sensitization to an allergen has not been reported. The results suggest that there is an interaction between smoking and damp housing conditions for mite sensitization. However, the majority of mite-sensitized farmers had never lived in a damp dwelling.

This study did not include any measurements of humidity levels in housing and the indicator of dampness in present dwelling (visible mould growth) was probably not appropriate for assessing whether the present dwelling was damp. A case control study with SM sensitized farmers will be needed to evaluate the relative importance of occupational exposure, damp housing conditions, and smoking, for the development of allergy to storage mites.

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