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Respiratory symptoms, pulmonary function and allergy to fur animals among fur farmers and fur garment workers

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Objectives This study determined the prevalence of respiratory symptoms and immediate hypersensitivity to fur allergens among fur farmers and fur garment workers and measured the pulmonary function of these groups of workers.

Methods Fur farmers (N = 188) and fur garment workers (N = 175) were compared with workers in a factory producing polyvinyl products (N = 181) and bank and health center workers (N = 118), respectively. The groups were given a self-administered questionnaire, lung function tests (spirometry, diffusing capacity), and skin prick tests to common environmental allergens, and epithelium (hair) and urine of fur animals.

Results Rhinitis symptoms and eye complaints were significantly more common among the fur garment workers than among their referents, but were not associated with atopy. Between the fur farmers and their referents, the symptom prevalence did not differ significantly. Smoking explained the lower forced vital capacity and forced expiratory volume in 1 second of the fur garment workers. The prevalence of positive skin tests did not differ significantly between the exposed group and their respective referents. The skin tests showed cross-reactivity between antibodies to fur and domestic animal allergens. As confirmed by a questionnaire sent to former fur workers, selection took place for both groups of fur workers.

Conclusions Fur garment workers have an excess of rhinitis and eye symptoms, which primarily appear to be nonimmunologic. Allergy to fur animals forces sensitized workers, especially asthmatics, to leave the trade. A supplementary questionnaire to former workers on pertinent exposures and reasons for leaving a particular job can be recommended for use in prevalence studies.

Key terms cross-reactivity, domestic animal allergens, fur animal allergens, questionnaire to former workers, respiratory disorders, skin prick test.

As an industry, fur farming and manufacturing increased in the mid-1980s and employed more than 20 000 workers at its economic height in Finland. Because of work-related allergic manifestations that were reported to the Finnish Institute of Occupational Health, we suspected that exposure to fur animal epithelium and urine causes occupational hypersensitivity or symptoms similar to those found among laboratory animal workers (1).

A Croatian study indicated that work in the fur industry may be associated with the development of chronic respiratory symptoms and impairment of ventilatory capacity in some workers (2). In an earlier Finnish cross-sectional study cough and shortness of breath were more frequent among fur farmers than among referents (3). The work-related respiratory symptoms of the fur farmers seemed to be associated with a positive skin test to mink urine. However, the results were obscured by other agricultural exposures because fur farming was a joint endeavor with other types of farming for the majority of the subjects. Alveolitis-like granulomas have been found in the lungs of 1 furrier (4).

We have earlier reported on the cross-reactivity between antibodies to fur animal allergens and domestic animal allergens (5) and on the total dust and microorganisms in the workplaces of fur farmers and fur garment workers (6). The objective of the present study was to assess the prevalence of respiratory symptoms, and the ventilatory capacity and hypersensitivity to fur animals of full-time fur farmers and fur garment workers.

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Subjects and methods

Subjects

The field study was carried out during 3 months from November 1987 to February 1988, when 2 groups of currently employed fur workers (fur farmers and fur garment workers) and their referents were examined and subjected to a questionnaire survey. The demographic characteristics of the study populations are presented in table 1.

All the workers employed by the 2 largest fur farming companies in Finland were asked to participate in the study. One hundred and eighty-eight (93%) accepted the invitation. An unexposed reference group (N = 190) was selected for these workers from a local company manufacturing tubes made of polyvinyl chloride (PVC) plastic; industrial hygiene measurements had earlier shown only minute concentrations of plastic fumes in the air of the work areas. Persons (N = 9) who had earlier worked in fur farming were omitted from the reference group; thus it contained 181 persons.

All the fur garment workers employed by the 4 largest manufacturing companies in Finland were invited to participate in the second exposed group, and 175 (96%) agreed. These workers were exposed to different furs, but especially to mink (90%) and various species of fox (87%). Their reference group (N = 118) consisted of unexposed workers from a local bank and the health center.

In addition, a questionnaire was sent to 510 formerly exposed fur workers and 745 formerly unexposed bank employees, health center employees and manufacturers of polyvinyl chloride products of the companies in this cross-sectional study. These workers had quit their job during the last 10 years. Seventy-five percent of the formerly exposed persons and 66% of the formerly unexposed persons responded.

Exposure to fur animals

The largest fur farms consisted of hundreds of outdoor cages in long rows close to each other. At their highest capacity they can have as many as 100 000 minks or foxes. During the period of this study the animals were treated, handled, and fed by 30—40 fur farmers. Seasonal tasks such as mating and skinning occurred in the spring and autumn and needed additional workers. The seasonal tasks were carried out in buildings that had no extra ventilation. The raw skins were preserved and transported to be auctioned directly or were sent to dressing firms.

The work conditions of the fur garment factories varied. One factory was only 5 years old; it was well planned and built for fur manufacturing with modern ventilation. Another had been in use for 20 years in an old-fashioned industrial setting, and a third was located in an apartment building. However, the layout of the process with the same kind of tasks and also the many dusty operations meant that all the workers were exposed to fur and other dusts in all these factories. Furs were dressed and dyed before the manufacturing process, but the dressing companies were not included in the study.

Questionnaire

Each subject completed a self-administered questionnaire about personal characteristics, respiratory symptoms, smoking habits, occupational history, and personal and family history of allergy and pulmonary diseases. The questionnaire was a Finnish translation of the standardized questionnaire used in a study of the wool textile industry (7) and was based on questions and definitions of the traditional MRC questionnaire (8).

The questions covered, for instance, the following items: cough, phlegm, shortness of breath, and wheezing. Symptoms of rhinitis and eye irritation were also included. The symptoms were considered work-related if they appeared in connection with any specific animal or fur tasks or improved during vacations lasting more than 1 week. A subject was considered a smoker if he or she regularly smoked at least 1 cigarette, cigar or pipe a day during 1 year and had smoked during the 6 months preceding the study. A person was defined as an ex-smoker if he or she had ceased smoking at least 6 months prior to the study.

Table 1. Demographic characteristics of the fur-exposed workers and their referents.

Group	Gender (%)		Age (years)			Length of employment (years)			Smoking (%)		
	Female	Male	Mean	SD	Range	Mean	SD	Range	Non-smokers	Ex-smokers	Current smokers
Fur garment workers (N = 175)	87	13	38.3	10.9	19—63	9.9	8.7	1—49	50	18	32
Referents of the fur garment workers (N = 118)	92	8	38.0	10.2	20—64	14.8	8.6	1—35	59	17	24
Fur farmers (N = 188)	13	87	35.6	11.7	17—64	12.7	8.8	2—43	29	21	50
Fur farmer referents (N = 181)	29	80	37.4	10.4	19—65	12.2	8.4	2—37	28	24	48

A detailed questionnaire about life-time exposure to domestic animals and childhood exposure to passive tobacco smoke was distributed later; answers were received from 148 (85%) fur garment workers and 102 (92%) of their reference group and from 154 (82%) fur farmers and 151 (83%) of their reference group.

The formerly exposed and unexposed workers were asked about respiratory and eye symptoms occurring during their work period, allergies before their work period, and the reasons for quitting.

Lung function tests

Spirometric measurements were taken from each subject with a wedge spirometer (Vitalograph®) according to the standards of the American Thoracic Society (9). The spirometer was calibrated each day with a 5-l syringe, and the volumes were corrected to conditions of body temperature and pressure, saturated with water vapor (BTPS). From the curves of the maximum expiratory flow volume, the highest forced vital capacity (FVC) and the forced expiratory volume in 1 second ($FEV_{1.0}$) were measured. All the values were also expressed as the percentages of the predicted values based on Finnish reference values (10). Only 1 person was unable to perform the spirometry.

Two trained persons, a laboratory nurse and an assistant, examined an equal number of persons. Their performance of the tests was compared before the study. The mean differences in the FVC of the persons tested was 2.0%.

The diffusing capacity of the lung for carbon monoxide (DL_{co}) was measured with the Morgan transfer test using the single-breath method. At least 2 successful consecutive measurements had to be performed, and the mean value of the 2 nearest test results was chosen (11). The values of the diffusion capacity and the specific diffusion capacity (DL_{co}/VA) were adjusted to the real-time hemoglobin measurement (12). The observed results were expressed as the percentages of predicted values in Finland (13). The measurements of diffusion capacity were distributed equally between 2 trained laboratory technicians. Before the study, a comparison of the technicians showed that the mean of the differences in the diffusion capacity of the persons tested was 3.6%. Due to technical difficulties diffusion capacity was not performed for 4 fur garment workers.

Skin prick tests

Fur and urine extracts were prepared from the following fur animals: mink (*Mustela vision*), silver fox (*Vulpes vulpes*), blue fox (*Alopex Lagopus*), raccoon (*Nyctereutes procyonoides*), and fitchew (*Mustela putorius*), as described earlier (5). Extracts other than those from fur animals were commercial glycerol-saline extracts (Allergologisk Laboratorium A/S, Copenhagen, Denmark). The common environmental allergens were timothy, birch, mugworth, house dust mite (*Dermatophagoideus pteronyssimus*), and *Cladosporium* (10 HEP). The extracts from domestic animals came from dog, cat, horse, cow, and swine (10 HEP).

Skin prick tests were performed on all the subjects. They were done by the prick method with a standardized disposable precision lancet (Dome/Hollister-Stier Ltd, Paris, France). The allergens were tested on the volar surfaces of both arms. The same trained nurse made all the tests, read the results 15—20 min after the pricking, and outlined the weal reactions on the skin with an ink drawing pen. The outlines of the weals were transferred with adherent tape to paper forms. The greatest diameter and the diameter perpendicular to it were measured for each weal. The mean of these diameters was the test result. A test was positive if the mean of the diameters in the test minus the mean of the diameters in the negative control was equally large or larger than 3 mm (14, 15). The prevalence of dermographismus was distributed equally among the study groups. A positive skin test to extracts from domestic animals implied that the skin prick test was positive to 1 or more domestic animal allergens (dog, cat, horse, cow or swine). Similarly, a positive skin test to common environmental allergens denoted a positive reaction to at least 1 common environmental allergen (birch, timothy, mugworth, *Cladosporium,* house dust mite). A person was considered atopic if he or she had at least 1 positive skin test to common environmental allergens. Domestic animals were not included in the definition of atopy because of expected cross-reactivity between immunoglobulin E (IgE) antibodies to domestic and fur animal allergens (16).

Extracts of urine from mink and silver and blue fox were used for nasal provocation of the symptomatic subjects in further examinations.

Immunoglobulin E

Total IgE was determined according to the instructions of the kit producer (Pharmacia Diagnostica, Sweden). The analysis of specific IgE antibodies, with a radioallergsorbent test (RAST), to fur animal extracts has been published separately (5).

Statistical analysis

Standard descriptive statistics were used to represent the responses. Chi-squared tests were used with 2x2 contingency tables to determine if the relationships between the nonparametric variables were statistically significant. The relative risks (odds ratios) were determined in a logistic regression analysis in which the discrete variables were corrected for confounding factors. The usual confounders used in each variable analysis were age, gender, smoking, atopy, and earlier lung disorders.

Table 2. Prevalence (%) of respiratory symptoms among the current fur-exposed workers and their referents.

Respiratory symptom	Fur garment work				Fur farming			
	Exposed workers		Referents		Exposed workers		Referents	
	Smokers (N = 88)	Nonsmokers (N = 87)	Smokers (N = 49)	Nonsmokers (N = 69)	Smokers (N = 134)	Nonsmokers (N = 54)	Smokers (N = 131)	Nonsmokers (N = 50)
Rhinitis	42.1*	34.5*	22.9	18.8	20.2	5.6	15.3	16.3
Eye complaints	31.0**	22.4	8.2	17.9	14.5	5.6	10.6	16.7
Wheezing	8.1	5.8	12.2	5.8	17.9	5.6	9.9	6.0
Shortness of breath[a]	14.9	5.8	14.3	10.1	8.2	5.6	8.4	6.0
Chest tightness	35.2	19.5	34.7	21.7	23.3	11.1	21.5	18.0
Breathlessness on exertion[b]	5.7	3.5	0.0	2.9	1.5	0.0	3.1	2.0
Cough[c]	17.1	2.3	8.2	7.3	13.4	5.6	9.2	8.0
Phlegm[c]	21.8	5.8	12.2	5.8	23.9	7.4	16.9	10.0
Cough and phlegm	10.2	2.3	4.1	4.4	9.7	3.7	5.3	6.0

[a] Shortness of breath and wheezing.
[b] Must stop walking at own pace on level ground (MRC grade 4).
[c] At least three months a year.
* $P < 0.05$, ** $P < 0.01$, comparison made with the corresponding smoking categories of the referents.

Student's 2-tailed t-test and an analysis of covariance were used to examine the relationship between the pulmonary functions and exposure. The continuous variables were corrected for age, gender, height, and smoking. Smoking was also used as a covariate, expressed as pack-years, which were transformed logarithmically in the analysis.

Results

Respiratory symptoms

The fur garment workers had significantly more rhinitis and eye complaints than their referents (table 2), the adjusted odds ratio being 2.55 [95% confidence interval (95% CI) 1.46—4.46] for rhinitis symptoms and 2.26 (95% CI 1.20—4.26) for eye complaints. The adjusted odds ratio was 3.14 (95% CI 1.70—5.78) for at least 1 of the following symptoms being work-related: cough, shortness of breath, chest tightness, rhinitis or eye complaints. Seventy-nine percent of the rhinitis symptoms and 83% of the eye symptoms were considered work-related by the fur garment workers. The fur farmers and their referents showed no differences in the prevalence of respiratory or eye symptoms.

The prevalence of any earlier allergic disease was 9% for the fur garment workers and 18% for their referents ($P = 0.023$). The prevalence of allergic rhinitis among parents or siblings was also higher for the referents (18%) than for the fur garment workers (8%) ($P = 0.01$).

Rhinitis and eye symptoms among the fur garment workers were not associated with atopy or earlier allergic diseases, but the rhinitis and eye symptoms among their referents were. Of the fur farmers with shortness of breath, 43% were atopic, while the corresponding figure for the asymptomatic fur farmers was 9% ($P = 0.001$). Smoking did not explain this finding.

The fur garment workers reported chills significantly more often (8%) than their referents (0.8%). No other indications of allergic alveolitis were found.

The clinical examinations of symptomatic workers revealed 5 new cases of occupational rhinitis (3 among fur garment workers and 2 among fur farmers) caused by fur allergens, whereas no occupational asthma was found. The diagnosis of rhinitis was confirmed with a nasal provocation test.

The fur farmers and their referents had a lower prevalence of rhinitis and eye symptoms than the former fur farmers and former referents (tables 2 and 3). Eye complaints and respiratory symptoms had however been more frequent during work among the workers who had changed jobs for health reasons (table 4) than among all the former workers (table 3). Especially the fur farmers and their referents who had changed jobs for health reasons reported high prevalences of symptoms during work. Sixteen percent of the former fur farmers had changed workplaces because of health complaints; 5 of

Table 3. Prevalence (%) of respiratory symptoms and earlier allergic disorders among the former fur-exposed workers and their referents.

	Fur garment work		Fur farming	
	Ex-exposed workers (N = 240)	Referents (N = 204)	Ex-exposed workers (N = 144)	Referents (N = 242)
Respiratory symptoms				
Rhinitis	38***	22***	34	29
Eye complaints	20***	7***	15	22
Wheezing or shortness of breath	8	5	10	8
Earlier allergic disorders				
Asthma	1	2	1	2
Allergic rhinitis	9	11	4	9
Allergic conjunctivitis	1	3	1	3
Allergic eczema	10	11	5	7
Any of above	15	21	8	15

*** $P < 0.001$.

Table 4. Prevalence (%) of respiratory and eye symptoms among the former fur-exposed workers and their referents who had left for health reasons.

Symptom	Fur garment work		Fur farming	
	Ex-exposed workers (N = 40)	Referents (N = 204)	Ex-exposed workers (N = 144)	Referents (N = 242)
Rhinitis	63	36	70	71
Eye complaints	55**	7**	26**	65**
Wheezing or shortness of breath	30	21	44*	16*
Earlier allergic diseases (any of them)	23	29	26	32

*P < 0.05, **P < 0.01.

them had asthma diagnosed by a physician in combination with work-related symptoms. By comparison, 13% of the former workers in the reference factory, 17% of the former fur garment workers, and only 7% of the former bank clerks or health center workers had left their job for health reasons.

Skin test

The prevalence of positive skin tests to fur animal extracts was similar for the different study groups (table 5), but the prevalence of positive skin tests to domestic animals was lower, although not significantly so, among the fur garment workers than among their referents. The prevalence of atopy was found to be distributed equally in the study group comparisons. Only 3 fur farmers and 1 fur garment worker with a positive skin test to fur animal extract had a high level of specific IgE antibody to the same fur animal extract.

There was a distinct overlapping between the positive skin tests to fur extracts and atopy. Of the persons with a positive skin test to fur allergens, 50% had a positive skin test to domestic animals and 43% to other common environmental allergens.

Table 5. Prevalence (%) of positive skin tests to fur animal allergens, domestic animal allergens, and common environmental allergens determined for the fur-exposed workers and their referents.

Type of sensitization	Fur garment work		Fur farming	
	Exposed workers	Referents	Exposed workers	Referents
Fur animal allergens[a]	6.9	8.5	8.5	6.1
Domestic animal allergens[b]	6.3	12.7	6.4	5.5
Common environment allergens[c]	15.4	15.3	11.2	9.4

[a] Positive skin test to one or more fur animal allergens (mink, blue fox, silver fox, fitchew, both hair and urine extracts).
[b] Positive skin test to one or more domestic animal allergens (dog, cat, horse, cow, swine).
[c] Positive skin test to one or more common environmental allergens (birch, timothy, mugworth, *Cladosporium*, house dust mite).

Lung function capacity

The fur garment workers had significantly lower FVC and $FEV_{1.0}$ values than their referents. In the covariance analysis adjusted for common confounders the amount and duration of smoking explained the differences. No difference in lung function was found between the fur farmers and their referents.

Discussion

The present study is the first large-scale survey of the prevalence of hypersensitivity symptoms and allergies among full-time fur workers. The fur garment workers studied had a high prevalence (38%) of rhinitis and eye symptoms. These symptoms were considered work-related in 75% and 83% of the cases, respectively. In contrast to the results of the reference group the manifestations were not associated with atopy or previous allergies; thus they were presumably not IgE-mediated. The prevalence of symptoms among the fur farmers did not differ from that of their referents.

The fur garment workers with a positive skin test to fur allergen did not have a higher prevalence of respiratory symptoms than those with negative skin tests. In a Croatian study chronic respiratory symptoms were more prevalent for furriers with positive skin tests, but not significantly so, and acute symptoms were not associated with positive skin tests to fur animal extracts (17).

In our cross-sectional population 5 cases (3 fur garment workers and 2 fur farmers) of occupational hypersensitivity rhinitis caused by fur allergens were diagnosed. Therefore, IgE-mediated allergy can be considered a hazard among both groups of fur workers. However, the occurrence of specific allergies to fur animals was smaller than expected.

There was a surprisingly high prevalence of chills among the fur garment workers. This solitary observation could be explained by the dusty operations. These symptoms were construed as indications of mild organic dust toxic syndrome rather than as allergic alveolitis; none of the other criteria for allergic alveolitis were found.

Surprisingly, the skin test positivity to fur animal extracts did not differ between the exposed and unexposed groups. The overlapping of the positive skin tests to fur animal allergens and domestic animal allergens indicated that there was cross-reactivity between IgE antibodies to domestic and fur animal allergens. We have confirmed the cross-reactivity by immunoblotting and RAST inhibition (5). IgE antibodies to dog and cat, but

not to cow, cross-reacted with antibodies to all the studied fur animal allergens.

In the immunoblotting and RAST inhibition studies the sera of some of the subjects with positive skin tests but negative RAST results to fur animal allergens showed binding to the same bands. Thus it is likely that the extracts of the skin tests had a suitable concentration. The sensitivity of the RAST assay may have been low.

Only 4 exposed workers, 3 of them fur farmers, were RAST positive to fur animal allergens. All of them had work-related respiratory symptoms; this finding indicates that occupationally sensitized workers had to leave the trade. The supplementary questionnaire study of former fur workers revealed selection out of fur work because of hypersensitivity symptoms and allergic diseases. Five fur farmers had changed jobs because of asthma and a deterioration of symptoms at work.

Because of the somewhat unexpected results, special attention was given to the choice of reference groups. Internal comparison was not considered practical as great variations in exposure intensities were not expected. Thus the reference groups were considered necessary. Farmers were considered unsuitable as referents for the fur farmers because of the variety of confounding exposures, as demonstrated by Keistinen (3). Workers in a plant producing plastics (PVC) were chosen as referents. They belonged to the same socioeconomic class, and work in the plant would have been a natural alternative to fur farming. An analysis of personal air samples from 10 workers showed low concentrations of plastic fumes (mean 0.3 mg/m^3). However, the questionnaire study revealed that former workers had suffered from eye irritation, which had also been a reason for quitting work (tables 3 and 4). Thus the referents had obviously been exposed to irritative fumes, probably in conjunction with process disturbances.

An ideal reference group for the fur garment workers was hard to find. Referents were chosen from a bank and a health center. A higher prevalence of earlier allergies among these referents, as well as allergies among close relatives compared with relatives of the fur garment workers, was noted. This finding indicated that either allergic persons may have sought white-collar jobs or may have avoided the dusty jobs in the fur industry. However, skin test results showing an equal prevalence of atopy did not support either explanation.

Prevalence studies are vulnerable to selection. Our experience shows that the use of retrospective questionnaire data from former workers can improve the reliability of prevalence studies in several ways. The supplementary questionnaire revealed that asthma in relation to work forced 5 fur farmers to leave their jobs. This job turnover was reflected in the remarkably low prevalence of physician-diagnosed asthma among both the fur farmers (1.1%) and the fur garment workers (0%). Moreover, dusty garment work is unlikely to attract asthmatics in the first place. There were also results indicating that workers from homes with animal allergies are less inclined to seek a job in an environment associated with animal exposure. The clerical workers and health personnel showed a prevalence of 3.7%, which equals that of asthma in the Finnish population (18). The supplementary questionnaire also revealed that the referents of the fur farmers were exposed to irritants, and this exposure probably caused asthmatics to change jobs. This is a probable explanation for the low prevalence of physician-diagnosed asthma (1.1%) also among the referents.

Aspects of selection, as well as sensitization, could have been better assessed in a follow-up study of newcomers; such studies are, however, rarely practical. The rapid economic recession of the fur trade in the early 1990s also hampered a follow-up of the cohort.

Concluding remarks

Fur garment workers have an excess of rhinitis and eye symptoms. The majority of these symptoms appear to be nonimmunologic, most likely irritative. IgE-mediated allergy to fur animals, especially asthma but also rhinitis, occurs both among fur garment workers and among fur farmers. Specific IgE-mediated allergy appears to force persons with symptoms to change jobs. Prevalence studies are vulnerable to selection biases. To disclose selection with respect to entering work as well as leaving work, the use of a supplementary questionnaire to former workers concerning their reasons for changing jobs is recommended.

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