

Animal allergen sensitization in veterinarians and laboratory animal workers

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Background	Animals secrete allergens into the environment and exposure to these in the workplace may cause sensitization.
Aims	To identify the frequency of animal allergen sensitization and symptoms in animal workers.
Methods	Using skin prick tests (SPT), we assessed sensitization to 15 mammal and bird allergens in animal workers and controls. We also recorded symptoms and pulmonary function tests.
Results	There were 100 animal workers and 50 controls included in the study. Thirty-six per cent of animal workers and 10% of controls had positive SPT ($P < 0.001$, odds ratio [OR] = 5.1, 95% CI 1.7–16.0). The most common sensitizations were to horse (16% in animal workers versus 0% in controls, $P < 0.01$), canary (16% in animal workers versus 2% in controls, $P < 0.05$, OR = 9.3, 95% CI 1.2–194), cattle (13% in animal workers versus 0% in controls, $P < 0.05$), cat (12% in animal workers versus 6% in controls, not significant), rabbit and hamster (10% each in animal workers versus 0% in controls, $P < 0.05$). Allergy symptoms were reported by 52 animal workers, but only 36 of them had positive SPT. Twelve animal workers had abnormal pulmonary function tests and six had positive SPT.
Conclusions	Animal workers are at high risk of occupational sensitization to animal allergens. Exposure should be minimized through control measures and worker education about the risks of exposure and sensitization.
Key words	Bird allergens; laboratory animal worker; mammalian allergens; veterinarians.

Introduction

Frequent exposure to animals carries a risk of sensitization to their allergens, which may lead to allergic symptoms [1]. Occupational exposure occurs in veterinary surgeons, animal caretakers, veterinary technicians and laboratory animal workers. Allergy to mammals is usually caused by recurrent contact with species such as cats, cattle, dogs and horses. The main sources of mammalian allergens are hair, dander, saliva and serum [1,2]. The main source of allergens in rabbits and rodents, such as gerbils, hamsters, rats and mice, is urine [3]. Airborne cat and dog allergens can be deposited in the workplace and have been extensively studied [4–6]. Bird allergens, from feathers, serum or droppings from canaries, chickens, ducks, geese and parakeets, can also cause occupational allergy [7,8]. Exposure to mammalian or bird allergens can elicit IgE-mediated reactions in sensitized persons. Frequent re-exposure to animal allergens leads

to allergic symptoms such as cough, wheezing, chest tightness, rhinorrhoea, nasal irritation and eye itching [9]. Skin prick testing (SPT) is informative and safe for detecting IgE-mediated allergen sensitization. However, few studies have investigated animal allergen sensitization in veterinary surgeons and animal workers. In this study, we aimed to identify the frequency of sensitization and allergic symptoms in laboratory animal workers, animal caretakers and veterinarians in south-western Iran.

Methods

We recruited study volunteers from the veterinary school and animal husbandry service of a university medical school in south-western Iran, between June and August 2013. We selected non-animal workers of the same ethnicity and from the same geographic region as a control group, by

random sampling of adults seen by their family physicians at university-affiliated hospitals for their annual check-up. The university ethics committee approved the study protocol and each participant gave written, informed consent.

From each participant, we obtained demographic details, smoking history, personal or family history of atopy, history of animal exposure and medical and occupational history. Using a self-completed questionnaire (available as [Supplementary data](#) at *Occupational Medicine Online*), we recorded respiratory, skin and eye symptoms after exposure to animals. Cough, wheezing and shortness of breath were considered pulmonary symptoms; rhinorrhoea, sneezing and nasal congestion were considered allergic rhinitis; itchy rash and urticaria were considered skin symptoms; and eye itching and redness were considered conjunctivitis. We considered symptoms as work-related if they started after exposure to animals at work. We excluded participants with dermatographism because of the contraindication for SPT [10], those who kept animals or birds at home and those with current severe common cold or influenza as these could affect spirometry results [11]. We also excluded participants at risk of complications from spirometry, including pregnant women, and those with recent brain, sinus, chest or abdominal surgery, hypotension or severe hypertension, significant arrhythmia, pneumothorax or a history of syncope related to forced exhalation [12].

For SPT, we used commercial mammalian epithelial allergens of cat, cattle, dog, goat, gerbil, hamster, horse, rabbit, rat and mouse, and bird feather extracts of canary, chicken, duck, goose and parakeet (Greer, Lenoir, WA, USA). We also used commercial extracts for two species of mite: *Dermatophagoides pteronyssinus* and *Dermatophagoides farina* (Greer). We used histamine (10 mg/mL) and saline as positive and negative controls, respectively. We analysed SPT results after 15 minutes and considered a wheal diameter >3 mm larger than the corresponding negative control as positive sensitization. We asked participants not to take antihistamine medication for 5 days before SPT. We recorded animal sensitization if there was at least one positive SPT reaction to mammal or bird allergen.

We measured pulmonary function by spirometry (Cosmed, Rome, Italy) in both groups. We measured forced vital capacity (FVC), forced expiratory volume in 1 second (FEV₁) and peak expiratory flow (PEF) and considered values <80% of the predicted value as abnormal [13]. We compared frequencies of positive SPT results between animal workers and controls with the chi-squared test using Epi Info version 6 software, and we considered $P < 0.05$ statistically significant.

Results

Of the 127 people eligible for this study, including 33 veterinarians, 12 veterinary technicians, 55 final year veterinary students and 11 animal caretakers at the veterinary

school and 17 laboratory animal workers in the animal husbandry service of the medical school, 107 individuals volunteered for the study. We excluded one animal worker because of dermatographism, three because of severe common cold, one because of recent myocardial infarction, one because of recent eye surgery and one because of recent appendectomy. One hundred animal workers, including 28 veterinarians, 9 veterinary technicians, 39 final year veterinary students, 8 animal caretakers and 16 laboratory animal workers, ranging in age from 21 to 60 (mean age 30 ± 8 years) were enrolled in the study, and the male:female ratio was 1:6. The duration of animal exposure ranged from 2 to 35 years. Monthly animal exposure ranged from 4 to 30 days, with a mean frequency of 23 ± 5 days per month. Fifty individuals ranging in age between 18 and 54 (mean 33 ± 9) with a male:female ratio of 1:2 were included in the control group. Participants in this group were not sex- and age-matched with the animal workers. None of the participants had a history of smoking or kept pets or birds at home.

Among animal workers, 46% reported a family history of atopic disorders, which did not seem to be related to their sensitization to animal allergens. Long-term workplace exposure (≥ 2 years) to dogs (89 workers), cattle (76), cats (74), horses (72), rabbits (68), mice (52), goats (50), rats (41), gerbils and hamsters (20 workers each) was reported. Bird exposure was reported to chickens (61 workers), canaries (45), parakeets (35), ducks (32) and geese (20).

We observed a positive SPT to at least one of the allergens in 36% of animal workers (14% to mammalian allergens, 5% to bird allergens and 17% to both mammalian and bird allergens), whereas the frequency of sensitization in the control group was 10% (two to cat, one to mouse, one to cat and dog, and the rest to mouse, rat, canary and parakeet; $P < 0.001$, odds ratio [OR] = 5.1, 95% CI 1.7–16.0).

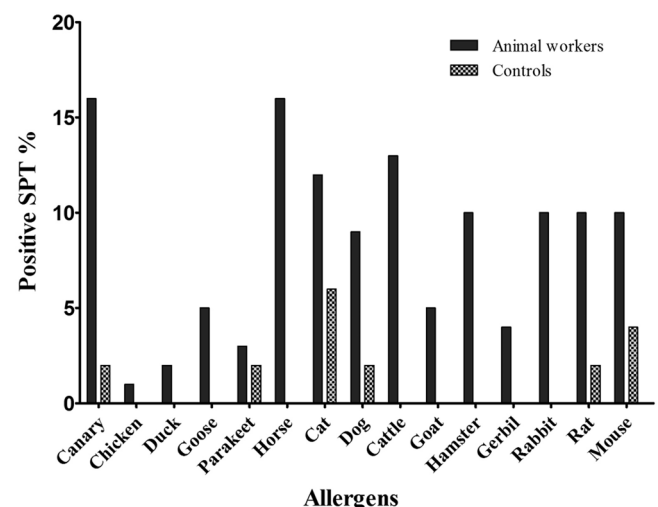


Figure 1. The rate of sensitization against 15 animal allergens in animal workers and controls.

Figure 1 shows the rates of positive reactions to 15 animal allergens tested by SPT in animal workers and controls. The most common sensitizations were to horse (16% in animal workers versus 0% in controls, $P < 0.01$), canary (16% in animal workers versus 2% in controls, $P < 0.05$, OR = 9.3, 95% CI 1.2–194), cattle (13% in animal workers versus 0% in controls, $P < 0.05$), cat (12% in animal workers versus 6% in controls, not significant), and rabbit and hamster (10% each in animal workers versus 0% in controls, $P < 0.05$).

Sensitization to animal allergens did not differ significantly between workers with 2–5, 6–10 and >10 years of animal exposure. Sensitization to animal allergens in workers with 4–20 days of animal exposure per month did not differ significantly from workers with >20 days of exposure per month.

Among animal workers, 36% were sensitized to one of the mite species and 21% were sensitized to both mite species. Frequency of sensitization to *D. pteronyssinus* did not differ significantly between animal workers and controls (24% versus 18%; not significant), whereas sensitization to *D. farina* was significantly more frequent in animal workers than controls (33% versus 16%; $P < 0.05$, OR = 2.6, 95% CI 1.0–6.7).

Occupational allergy symptoms were reported by 52 animal workers (rhinitis in 37, asthma in 34, conjunctivitis in 33 and skin allergy in 29), but 19 of these showed no skin reaction to any of the animal allergens tested. Three animal workers with no history of clinical symptoms showed positive skin reactions to one or more of the allergens. Of 67 veterinarians, veterinary students and technicians, allergic rhinitis was reported by 26 (39%), allergic conjunctivitis by 21 (31%), asthma by 20 (30%) and skin symptoms by 17 (25%).

Table 1 shows the mean values of spirometry indices in animal workers and controls. Twelve animal workers had abnormal spirometry indices: in nine workers, PEF was <80% and in three workers FEV₁/FVC was <80% of the predicted value. We detected sensitization to animal allergens in six of these workers. The rate of sensitization to animal allergens, work-related symptoms and abnormal spirometry results in different subgroups of animal workers are summarized in Table 2. Compared with controls, we found no significant difference in the rate of sensitization to animal allergens in animal

caretakers (0% versus 10% in controls), veterinary technicians (22% versus 10% in controls) or laboratory animal workers (37% versus 10% in controls). However, we did find significant differences in the rate of sensitization in veterinarians (43% versus 10% in controls, $P < 0.001$, OR = 6.8, 95% CI 1.8–26.5) and final year veterinary students (41% versus 10% in controls, $P < 0.001$, OR = 6.3, 95% CI 1.8–22.6).

Discussion

We found animal allergen sensitization in 36% of animal workers and 10% of controls. Veterinarians and final year veterinary students showed the highest rate of sensitization to animal allergens.

A potential confounder was whether participants in both groups kept pets (mammals or birds) at home, although all participants said that they did not. A further limitation was failure to match controls and animal workers for sex and age. Animals that share common allergens [14] may be kept together, so we used a panel of different mammal and bird allergens for SPT. Although animal allergens arise from dander, epithelium, fur, urine or saliva [15], we used a restricted panel of allergens that included mammalian epithelium and bird feathers.

We found a rate of sensitization to mammalian allergens of 31% (14% to mammals only and 17% to mammals and birds). Krakowiak *et al.* [7] found allergies to animal fur (dog, cat, rat, mouse, rabbit, guinea pig and hamster) in 26% of zoo workers; however, we used additional allergen extracts, i.e. cattle, horse and goat. We found the highest rate of sensitization was to horse allergen (16%); which is consistent with a similar study from Turkey that found a sensitization rate of 13% to horse hair among horse grooms [16]. However, a study of veterinary students from the Netherlands reported a sensitization rate of <2% to horse [17]. The study involved different races of horse and different epitopes of horse allergens. Iranians are less likely to develop tolerance because of limited exposure to horses. Cross-reactivity to common mammalian allergenic epitopes may occur [18]. We found sensitization to birds in 22% of animal workers (5% to bird allergens only and 17% to mammal and bird allergens), and in 2% of controls. Two studies of Polish bird keepers found sensitization rates to feather allergens of 18% in 2002 and 8% in

Table 1. Spirometry indices in animal workers and controls (mean ± standard deviation)

Group	FEV ₁ (l) (% of predicted value)	FVC (l) (% of predicted value)	FEV ₁ /FVC ratio	PEF (l/s) (% of predicted value)
Animal workers	4.0 ± 0.8 (104 ± 15)	4.4 ± 0.9 (112 ± 14)	113 ± 6	9.4 ± 9.3 (109 ± 26)
Sensitized to mammalian allergens	4.1 ± 0.9 (101 ± 14)	4.4 ± 0.9 (109 ± 16)	113 ± 6	9.0 ± 2.7 104 ± 30
Sensitized to bird allergens	4.2 ± 1.1 (99 ± 14)	4.5 ± 1.1 (108 ± 16)	113 ± 5	8.4 ± 2.6 (97 ± 18)
Control group	5.0 ± 0.6 (105 ± 17)	5.5 ± 0.7 (114 ± 17)	112 ± 10	9.9 ± 1.4 (91 ± 7.0)

l, litres; l/s, litres per second.

Table 2. Animal allergen sensitization rate, work-related symptoms and abnormal spirometry in subgroups of animal workers

Animal workers	Positive SPT to animal allergens, <i>n</i> (%)	Work-related symptoms, <i>n</i> (%)	Abnormal spirometry, <i>n</i> (%)
Veterinarians (<i>n</i> = 28)	12 (43)	16 (57)	1 (4)
Final year veterinary students (<i>n</i> = 39)	16 (41)	17 (44)	3 (8)
Veterinary technicians (<i>n</i> = 9)	2 (22)	2 (22)	2 (22)
Laboratory animal workers (<i>n</i> = 16)	6 (38)	14 (88)	5 (31)
Animal caretakers (<i>n</i> = 8)	0	3 (38)	1 (13)
Total (<i>n</i> = 100)	36	52	12

2012, the difference possibly being related to the use of protective equipment [7,8]. We found sensitization to cat allergen in 6% of controls although most of these sensitized individuals had no symptoms. Immunological tolerance may be induced because of frequent exposure to cats [19]. Although we excluded participants who kept pets at home, feral cats are common in the area and contact is frequent. Rats and mice are commonly used in experimental research and allergy to them is a major problem in laboratory animal workers [20]. We found that sensitization to mouse and rat allergens was commonest among laboratory animal workers (37%). We found sensitization to two species of house dust mite in 36% of animal workers and 16% of controls. Mites feed on animal and human scales [21], so sensitization to mite allergens may be influenced by personal hygiene, home and workplace sanitation rather than strictly occupational factors.

Exposure to workplace airborne animal allergens leads to sensitization [17]. Animal allergens are important causes of IgE-mediated allergic reactions such as asthma, rhinitis, urticaria and conjunctivitis [18]. Animal-related respiratory and/or skin symptoms were found in 66% of California veterinary surgeons in a self-completed questionnaire study; allergic rhinitis was found in 62%, asthma in 16% and atopic dermatitis in 11% [22].

Nineteen animal workers with allergy symptoms had negative animal allergen SPT. Negative skin tests in symptomatic individuals may be due to non-IgE-mediated mechanisms [10]. Three animal workers with positive animal allergen SPT reported no clinical symptoms after exposure to animals. Positive skin test results in asymptomatic individuals may be a risk factor for the development of allergy [23]. Animal workers should be periodically screened, their symptoms should be recorded and appropriate measurements, including serum-specific IgE, should be taken.

We found abnormal pulmonary function in 12 animal workers. Inhalation of airborne animal allergens can induce airway inflammation and occupational asthma [9] and increase severity of existing disease. Only 6 of the 12 animal workers with abnormal spirometry had positive animal allergen SPT. This might be explained by our limited panel of allergens. Animal workers with negative SPT could be tested with other animal allergens such as rodent

urine [20]. Inhalation of endotoxins and glucans in the workplace may cause pulmonary symptoms and disease [24,25], and high ozone levels in summer may also worsen lung function without allergic sensitization [26]. Although SPT and specific IgE tests have similar diagnostic value for atopic diseases [27], the latter is more specific [28]. Moreover, specific IgE levels correlate with compromised pulmonary function and asthma severity [29,30].

Animal workers have close contact with animals in clinics and on farms, so proper ventilation and protective equipment such as masks, gloves, glasses, clothing and footwear may help to reduce the risk of sensitization. Despite the availability of such protective equipment, some veterinary students in this study did not use them consistently. The much lower rate of sensitization in veterinary technicians and animal caretakers who worked in the same conditions may reflect better use of protection. Occupational allergy might be expected to worsen as veterinary students are increasingly exposed to animals throughout training and employment; so education is important to reduce their risk of sensitization to animal allergens. Although the workplaces in this study had ventilation systems, animal workers worked in old buildings. Renovation and installation of modern ventilation systems could improve working conditions and reduce the risk of sensitization by lowering allergen loads.

Comparing animal allergen sensitization rates between institutions or countries with differential implementation of health surveillance and/or control measures to reduce allergen exposure might help to determine the effectiveness of such measures.

Key points

- Veterinarians and laboratory animal workers are at high risk of occupational sensitization to animal allergens.
- Animal workers should receive education about the risk of allergen exposure and how to minimize their risk of sensitization at the beginning of their employment or training.
- It is important to control exposure to airborne animal allergens at work to reduce the risks of allergic sensitization.

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Conflicts of interest

None declared.

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Questionnaire
for
Sensitization to animal allergens in veterinarians and animal workers

Name: Tel/Cell phone number: Workplace address:
Sex: Age: Height: Weight:
Job: • Veterinarian • Last-year veterinarian student • Veterinarian technician • Laboratory animal worker • Animal caretaker
Duration to exposure to animals: Years: Days per month:
History of smoking: • Current smoker: Yes No • Ever smoker: No Yes: Duration-----
Personal history of atopy: Yes No Family history of atopy: Yes No
Pets or other animals at home: Yes No
Animal exposure at workplace (≥ 2 years): • Canary • Goose • Duck • Chicken • Parakeet • Cat • Cattle • Dog • Gerbil • Goat • Hamster • Horse • Mouse • Rabbit • Rat
History of diseases: ▪ History of any special disease: No Yes ----- ▪ History of any surgery: No Yes ----- ▪ History of any autoimmune disease: No Yes ----- ▪ History of any cancer: No Yes ----- ▪ Under treatment with any special medication(s): No Yes -----

Clinical symptoms after animal exposure:**a) Allergic rhinitis**

- **Rhinorrhea**
- **Nasal congestion**

b) Pulmonary symptoms

- **Cough**
- **Wheezing**
- **Shortness of breath**

c) Skin symptoms

- **Itchy skin rash**
- **Urticaria**

d) Conjunctivitis

- **Eye itching**
- **Redness**

Results of skin prick test:

Material	Size of wheal	Size of erythema
Histamine as positive control		
Normal saline as negative control		
Extract of canary feathers		
Extract of chicken feathers		
Extract of cat epithelium		
Extract of cattle epithelium		
Extract of dog epithelium		
Extract of duck feathers		
Extract of gerbil epithelium		
Extract of goat epithelium		
Extract of goose feathers		
Extract of hamster epithelium		
Extract of horse epithelium		
Extract of mouse epithelium		
Extract of parakeet feathers		
Extract of rabbit epithelium		
Extract of rat epithelium		
Extract of <i>D. pteronyssinus</i>		
Extract of <i>D. farinae</i>		

Results of spirometry:

FEV1%	FVC%	FEV1/FVC	PEF%