ORIGINAL ARTICLE

Allergy among veterinary medicine students in The Netherlands

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Accepted 5 May 2011
Published Online First 31 May 2011

ABSTRACT

Background Veterinary medicine students who practice with animals are potentially exposed to many occupational agents, yet sensitisation and allergic symptoms among this group have not been studied extensively.

Objective The objective of this study was to estimate the prevalence of sensitisation and allergic symptoms in veterinary medicine students in association with study specialisation over time.

Methods A questionnaire-based cross-sectional study was conducted. Blood was collected and tested for total and specific serum IgE for 16 different common and study-specific allergens using enzyme immunoassay.

Results New development of self-reported allergic symptoms to various allergens occurred in 8.7%, of which 44% was deducted against animals. Handling farm animals was strongly associated with self-reported allergies to various allergens (OR=6.9, 95% CI 1.9 to 25) and animal allergens (OR=12, 95% CI 1.4 to 103). Sensitisation to at least one allergen occurred in 33.1%. Sensitisation prevalence tended to be elevated in later years of the equine study program. In contrast to self-reported allergies, the prevalence of sensitisation to any allergen decreased with prolonged study duration for those specialising in farm animal health (years 3–5: OR=0.5, 95% CI 0.3 to 1.1; year 6: OR=0.2, 95% CI 0.1 to 0.5). This was independent of whether people were raised on a farm, which is in itself a protective factor for allergy and sensitisation.

Conclusion This study provides evidence of an elevated prevalence of allergic symptoms with increasing years of veterinary study, suggesting that contact with animals, more specifically contact to farm animals, is a risk factor for the development of symptoms.

What this paper adds

- Veterinary medicine students during practice with animals can be potentially exposed to many occupational agents, yet sensitisation and allergic symptoms among this group have not been studied extensively.
- This study provides evidence of an increased prevalence of (allergic) symptoms with elevated years of veterinary study, suggesting that contact with animals is a risk factor for the development of symptoms.
- Handling farm animals emerged as the strongest risk factor for the onset of self-reported symptoms.
- Since (allergic) symptoms are likely to occur through veterinary practice, medical surveillance should be considered throughout the studies.

INTRODUCTION

Veterinarians and coworkers are potentially exposed to various occupational hazardous agents such as allergens shed by animals and plants,[1] microbial agents (eg, endotoxins)[1–3] and chemical agents (eg, disinfectants).[4] Exposure to animal-derived allergens are well known to induce immediate (IgE-mediated) sensitisation[5] and development of respiratory, eye and skin symptoms, as well as allergic asthma.[6–9] There are only a few published studies describing allergic symptoms among veterinary populations.[6 7 9–14] These studies suggest that veterinary populations are at risk of developing allergic sensitisation, allergic rhinitis, conjunctivitis, asthma and dermatitis, with prevalences ranging between 40% and 69% for respiratory symptoms[7 10 15] and 11% and 46% for dermal symptoms.[12–14]

Studies among laboratory animal workers exposed to rodents show that allergies can develop within months after first exposure.[16 17] This prompted us to hypothesise that veterinary medicine students, who come into contact with animals during their education, might be at risk of developing allergy. We thus conducted a cross-sectional investigation on the prevalence and self-reported incidence of allergic symptoms in all veterinary medicine students studying in the year 2006. In addition, sensitisation to various allergens was investigated. Since students follow specialisation-specific study paths (individually kept animals, equine, companion animals and farm animals), this information could be used as a surrogate of exposure to specific agents. The main objective of this study was to explore the occurrence of self-reported allergic symptoms and sensitisation among veterinary medicine students in association with study specialisation and study duration.

METHODS

Study design and population

For this cross-sectional investigation, all 1416 students who were registered as a veterinary medicine student in 2006 at the Utrecht University in the Netherlands were invited to participate and asked to complete an internet-based

self-administrated questionnaire. Additionally, they were invited to provide a 20 ml blood sample for serological IgE testing. Up to two reminders were sent to non-responders.

Questionnaire

The questionnaire included questions on demographic characteristics, history of and current contact with animals outside the study program, growing up on a farm (farm childhood) and smoking status. Information on previous and current contact with animals besides animal contacts during the study was ascertained for horse, farm animals (cow, sheep, pig, goat and poultry) and some of the more important pet species (cat, dog and rodent). A farm childhood was derived from the question 'Did you live on a farm during childhood?' Smoking status was divided into current smokers, non-smokers and former smokers.

The health assessment part of the questionnaire addressed questions on airway and allergic symptoms. Questions on airway symptoms were adopted from the Dutch version of the European Community Respiratory Health Survey questionnaire,[18] and questions on allergic symptoms were ascertained as previously,[19] with the main question on allergy: 'Are you sensitive or allergic to one or more agents?' If the answer was 'yes', then the participants were asked to report whether they have nose, eye, respiratory or skin symptoms to a possible list of allergens, including animals, house dust or grass pollen. Information on the time course of the allergy being before or after starting the veterinary medicine study was ascertained. The self-reported allergy was considered as new onset when the initiation of the allergy was reported to occur after the veterinary medicine study was started. Self-reported bronchial hyperresponsiveness was defined as experiencing difficulties in breathing in one of the following situations: fog, baking and frying, change in temperature, freezing cold or smoke.[19]

As a potential risk factor, we studied the diversity and duration of specialisation within the veterinary medicine curriculum. The veterinary curriculum was divided into two main categories: individually kept animals and farm animal health. After the first and second year in these study directions, the curriculum was subdivided into specialisation as companion animals or equine for the individually kept animal direction and as animal husbandry together with veterinary public health or farm animals for the farm animal health direction. During the third to fifth year within the specialisation, the students have most theoretical and some practical courses. In the sixth year of the specialisation, the students follow internships for their specific study direction. The type of animals being encountered mostly during the curriculum differed for the different specialisations, being mainly cats and dogs for companion animal specialisation, horses for equine specialisation and farm animals such as cows, sheep, goats, pigs and poultry for farm animal health.

Total and specific serum IgE

Sera were stored at −20°C until IgE analysis was performed. Total serum IgE antibody was quantified using a sandwich enzyme immunoassay as described previously.[20] The results were expressed in kilo units per litre. Enhanced total IgE was defined as ≥100 kU/l. Specific serum IgE antibodies for 16 different allergens—including common allergens (house dust mites, grass mixture (1:1 mixture of *Lolium perenne* and *Phleum pratense*), birch pollen (*Betula verrucosa*), cat fur and dog fur), laboratory or domestic animal allergens (rat urine, mouse urine, budgerigar feather, guinea pig hair and skin scrape), horse allergen (horse hair and dander), farm occupational allergens (cow hair and dander, goat hair and skin scrape, pig feces, pig skin scrape and chicken feces)—were measured by means of enzyme immunoassay as described elsewhere.[20] This method previously showed to be very well correlated to skin prick test positivity, as well as to Phadiazym RAST.[20] Serum was tested in a 1:5 dilution. Sera with an optical density (OD) of 0.05 and above, following correction for the OD of serum blank and OD of reagent blank, were considered to contain specific IgE for the tested allergen. Participants were considered to be sensitised to an allergen group, for example, common allergens, domestic allergens and farm animal allergens, if they tested positive for at least one of the specific allergens within the group.

Statistical analysis

Total IgE levels were best described by a log normal distribution; subsequently, geometric means and geometric SDs were calculated. Multiple logistic regression analysis was performed to associate the prevalence of self-reported respiratory and skin symptoms, self-reported allergy and sensitisation with different exposure groups based on study specialisations over time. The first 2 years of the specific study specialisations are the reference. ORs and 95% CIs were calculated and adjusted for potentially confounding variables including gender, smoking status and farm childhood. All statistical analyses were performed with SAS V.9.1 (Statistical Analysis Software; SAS Institute Inc).

RESULTS

Of the 1416 veterinary medicine students approached, 968 (68.4%) responded to the questionnaire, of which 673 (70.3%) provided a blood sample as well. Seven participants were excluded for further analyses: three because they did not complete the whole questionnaire and four because of a too small number in their specific specialisation. Numbers and percentage of participants per study specialisation and phase are depicted in figure 1.

Table 1 presents the demographic characteristics of the study population. The population was predominately women (80.3%). Only 5.5% was older than 30 years (ranged from 18 to 47 years). Current smokers were more likely to be men (16.4%) than women (9.2%). Most subjects had previous or current contact with animals outside the study program. About 25.8% of the study population reported a history of allergy prior to commencement of veterinary medicine study. This was independent of study specialisation or gender (26.2% women and 24.7% men). Participants with a history of allergy were more likely to provide a blood sample (27.8% vs 21.2%, p=0.03). The geometric means total IgE was 20.1 kU/l (geometric SDs 9.5), with 24.2% of sera being above 100 kU/l.

The association between self-reported health symptoms and categories of study specialisation is presented in table 2. The most commonly reported symptom was rhinitis, with an overall prevalence of 58.8%. The prevalence of various symptoms were more likely to report in the higher years of study, particularly during farm animal specialisation, compared with the reference groups, except rhinitis where companion animal students reported less symptom of rhinitis with increasing years of study (years 3–5, OR=0.7 (95% CI 0.5 to 1.0); year 6, OR=0.5 (95% CI 0.3 to 0.8)) compared with the reference group. Dermatitis was reported more often during practice with animal husbandry in years 3–5 (OR=4.2 (95% CI 1.5 to 14)) and farm animals in year 6 (OR=2.4 (95% CI 1.7 to 8.5)) than the reference group.

Self-reported new-onset allergies (developed during the veterinary education) occurred in 8.7% of the population (men 9.0% vs women 8.7%, table 3), with a tendency of higher prevalence

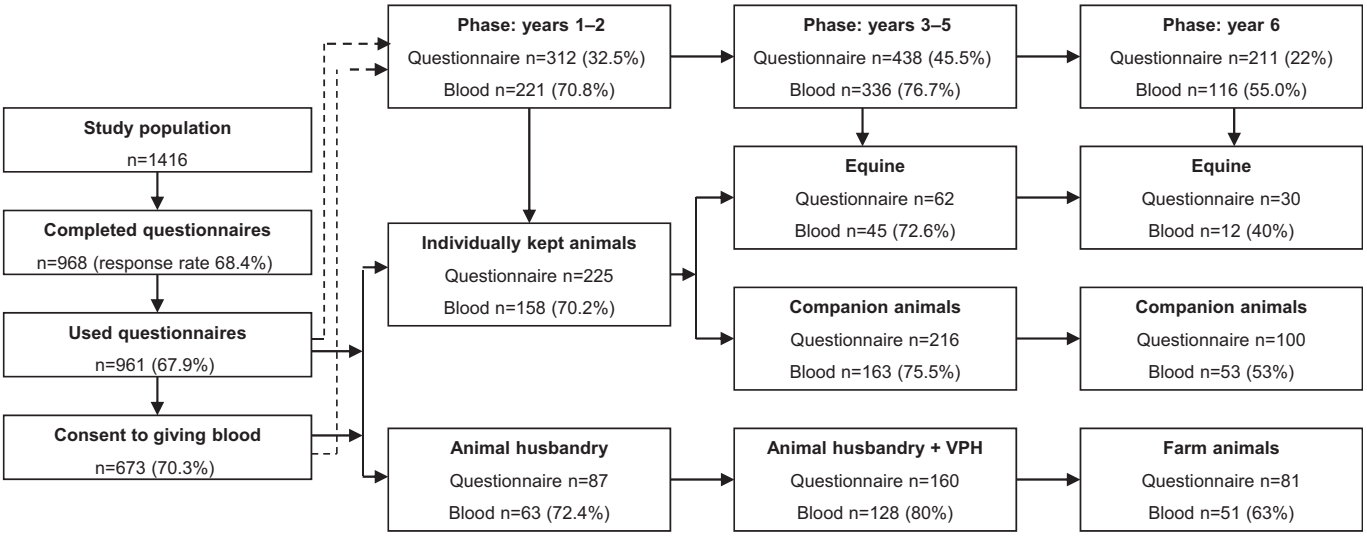

Figure 1 Flow diagram shows recruitment of the study population, number and relative proportion of participants in the different specialisations. VPH, veterinary public health.

with increasing years of study. Of those reporting allergic symptoms to various allergens, 44% reported animal allergy, with sneezing or runny nose as the most common symptoms (59.4%). About 10.8% of those with animal allergy were also allergic to grass and house dust, while 51.4% exclusively reported animal allergy. Working with farm animals appeared to be the strongest risk factor associated with self-reported symptoms of allergy to various allergens (OR=6.9, 95% CI 1.9 to 25, $p<0.05$) and to animal allergens (OR=12, 95% CI 1.4 to 103, $p<0.05$). Students in the final year of the companion animal or equine specialisation also tended to report more often the development of allergies.

Based on the serological evaluation, 33.1% of participants appeared to be sensitised to at least one specific allergen (table 4). Highest sensitisation prevalence was found for grass pollen (16.2%) and house dust mite (12.9%). Sensitisation to animal allergens was less common with the highest prevalence for cow allergen (3.7%). Only 1.3% of all tested students were sensitised to dog, and none were sensitised to chicken.

Presence of positive specific IgE to any allergen was diminished for participants in years 3–5 (overall: OR=0.5, 95% CI 0.3 to 1.1, $p<0.05$) and in year 6 (overall: OR=0.2, 95% CI 0.1 to 0.5, $p<0.05$) of the farm animal specialisation compared with the reference group (table 4). This is in contrast to the self-perceived (allergic) symptoms (table 3). In the equine specialisation group, participants in the sixth year were more likely to be sensitised to horse allergen, albeit not being statistically significant ($p>0.05$).

Growing up on a farm is in itself protective against sensitisation to allergens (OR=0.6, 95% CI 0.3 to 1.0). Nonetheless, adjusting for farm childhood did not change the association between allergic symptoms or sensitisation with study specialisations and over time.

A substantial number of participants with new onset of self-reported allergic symptoms did not have specific IgE. Of those reporting allergic symptoms to various allergens or to specific animal allergens, 47% and 77%, respectively, had no specific IgE, suggesting an over-representation of self-perceived symptoms. Conversely, 86.5% of sensitised individuals had no new self-reported symptoms of allergy. This number is an overestimation though, as those who reported symptoms prior to commencement of veterinary medicine study were excluded in the analyses. When taking into account self-reported symptoms before the study, the number of participants with sensitisation who did not report symptoms decreased to 38.3%.

Being sensitised to farm animals, horse, cat or dog allergens was in itself strongly and positively associated with the prevalence of symptoms, including wheezing (in the last year or without a cold), wheezing with shortness of breath, asthma attack (ever, last year or diagnosed by doctor) and itchy and red skin (range in ORs 2.3–15, $p<0.05$).

Table 1 Descriptive characteristics of study participants

Population characteristics	Total 961	Giving blood 673 (70%)	Non-giving blood 288 (30%)
Women, n (%)	772 (80.3)	539 (80.1)	233 (80.9)
Weight (kg), AM (SD)	68.5 (11.2)	68.3 (10.7)	69.1 (12.2)
Height (cm), AM (SD)	175 (8.3)	174 (8.2)	175 (8.5)
Age, AM (SD)	23.7 (3.7)	23.7 (3.6)	23.8 (3.8)
Smoking status			
Current smoker, n (%)	102 (10.6)	69 (10.3)	33 (11.5)
Former smoker, n (%)	85 (8.8)	60 (8.9)	25 (8.7)
Non-smoker, n (%)	774 (80.5)	544 (80.8)	230 (79.9)
History of allergy			
Yes, n (%)	248 (25.8)	187 (27.8)	61 (21.2)
Farm childhood			
Yes, n (%)	110 (11.5)	25 (8.7)	85 (12.6)
Previous or current contact with animals outside the study			
Horse, n (%)	648 (67.2)	451 (67.0)	195 (67.7)
Farm animals, n (%)	491 (51.1)	348 (51.7)	143 (50.0)
Pets, n (%)	938 (97.6)	659 (98.0)	279 (97.0)

AM, arithmetic mean.

DISCUSSION

To the best of our knowledge, this is the first study to document the prevalence of adverse health outcomes among veterinary medicine students, in which the associations between self-reported allergic symptoms and sensitisation determined by specific IgE with study specialisations as a surrogate of specific animal exposure have been investigated.

The overall prevalence of new-onset self-reported symptoms of allergy to animals was 3.9% (n=37). This figure should be interpreted as an incidence as only new-onset allergic symptoms were included. An incidence of 3.9% is lower than the 20%

Table 2 Prevalence and adjusted ORs (95% CIs) for symptoms per study specialisation

		Individually kept animals									Farm animal health				
		Individually kept animals* Years 1–2 (n=225)	Equine				Companion animals				Animal husbandry† Years 1–2 (n=87)	Animal husbandry+VPH		Farm animal	
			Years 3–5 (n=62)		Year 6 (n=30)		Years 3–5 (n=216)		Year 6 (n=100)			Years 3–5 (n=160)		Year 6 (n=81)	
	Total (n=961) n (%)	n (%)	n (%)	OR (95% CI)	n (%)	OR (95% CI)	n (%)	OR (95% CI)	n (%)	OR (95% CI)	n (%)	n (%)	OR (95% CI)	n (%)	OR (95% CI)
Chronic cough (3 months in last year)	78 (8.1)	16 (7.1)	4 (6.5)	0.9 (0.3 to 2.6)	3 (10.0)	1.2 (0.3 to 4.5)	23 (10.7)	1.5 (0.8 to 2.9)	6 (6.0)	0.8 (0.3 to 2.0)	6 (6.9)	9 (5.6)	0.7 (0.2 to 2.2)	11 (13.6)	2.1 (0.7 to 6.0)
Chronic phlegm (3 months in last year)	55 (5.7)	7 (3.1)	3 (4.8)	1.6 (0.4 to 6.4)	2 (6.7)	1.5 (0.3 to 8.1)	22 (10.2)	3.3 (1.4 to 7.9)	3 (3.0)	0.9 (0.2 to 3.5)	4 (4.6)	5 (3.1)	0.6 (0.2 to 2.2)	9 (11.1)	2.3 (0.7 to 7.8)
SOB	54 (5.6)	10 (4.4)	6 (9.7)	2.3 (0.8 to 6.6)	1 (3.3)	0.7 (0.1 to 6.0)	14 (6.5)	1.5 (0.6 to 3.4)	6 (6.0)	1.4 (0.5 to 3.9)	3 (3.5)	8 (5.0)	1.5 (0.4 to 6.0)	6 (7.4)	2.2 (0.5 to 8.9)
Wheezing (last year)	108 (11.2)	24 (10.7)	7 (11.3)	1.0 (0.4 to 2.4)	4 (13.3)	1.1 (0.3 to 3.3)	32 (14.8)	1.4 (0.8 to 2.4)	16 (16.0)	1.5 (0.8 to 3.3)	5 (5.8)	13 (8.1)	1.4 (0.5 to 4.2)	7 (8.6)	1.6 (0.6 to 5.2)
Wheezing (without a cold)	61 (6.4)	11 (4.9)	4 (6.4)	1.2 (0.4 to 3.9)	1 (3.3)	0.7 (0.1 to 5.4)	18 (8.3)	1.6 (0.7 to 3.6)	11 (11.0)	2.3 (0.9 to 5.7)	3 (3.5)	9 (5.6)	1.7 (0.5 to 6.3)	4 (4.9)	1.5 (0.3 to 6.7)
Wheezing with SOB	73 (7.6)	12 (5.3)	4 (6.4)	1.2 (0.3 to 4.3)	3 (10.0)	2.0 (0.6 to 7.4)	22 (10.2)	2.0 (1.0 to 4.2)	10 (10.0)	2.0 (0.9 to 4.7)	4 (4.6)	11 (6.9)	1.9 (0.5 to 6.7)	7 (8.6)	2.0 (0.4 to 7.0)
Breathlessness with wheezing	26 (2.7)	4 (1.8)	3 (4.8)	1.8 (0.7 to 5.2)	NA	–	6 (2.8)	2.1 (1.0 to 4.3)	3 (3.0)	1.6 (0.6 to 4.0)	2 (2.3)	6 (3.8)	1.4 (0.4 to 4.5)	2 (2.5)	2.1 (0.6 to 7.0)
Chest tightness	81 (8.4)	23 (10.2)	5 (8.1)	0.7 (0.3 to 2.1)	4 (13.3)	1.4 (0.4 to 4.2)	20 (9.3)	0.9 (0.5 to 1.8)	6 (6.0)	0.6 (0.2 to 1.5)	8 (9.2)	6 (3.8)	0.4 (0.1 to 1.1)	6 (7.4)	1.2 (0.5 to 3.2)
Asthma															
Asthma attack (ever)	77 (8.0)	21 (9.3)	7 (11.3)	1.2 (0.5 to 3.0)	2 (6.7)	0.7 (0.2 to 3.1)	14 (6.5)	0.7 (0.3 to 1.4)	9 (9.0)	1.0 (0.4 to 2.3)	5 (5.8)	11 (6.9)	1.5 (0.5 to 4.6)	9 (11.1)	1.8 (0.5 to 5.6)
Asthma attack (last year)	27 (2.8)	8 (3.6)	3 (4.8)	1.4 (0.3 to 5.2)	2 (6.7)	1.9 (0.4 to 9.6)	4 (1.9)	0.5 (0.2 to 1.8)	4 (4.0)	1.2 (0.3 to 3.8)	1 (1.2)	3 (1.9)	1.6 (0.2 to 16.0)	8 (9.9)	2.2 (0.2 to 24)
Asthma diagnosed by doctor	70 (7.3)	19 (8.4)	7 (11.3)	1.4 (0.6 to 3.5)	1 (3.3)	0.4 (0.0 to 2.9)	14 (6.5)	0.8 (0.4 to 1.5)	8 (8.0)	0.9 (0.4 to 2.2)	5 (5.7)	10 (6.3)	1.1 (0.4 to 3.3)	2 (2.5)	1.2 (0.4 to 4.2)
Asthma-like symptoms	153 (15.9)	37 (16.4)	9 (14.5)	0.8 (0.3 to 1.8)	7 (23.3)	1.4 (0.5 to 3.8)	43 (19.9)	1.2 (0.7 to 2.0)	18 (18.0)	1.1 (0.6 to 2.0)	10 (11.5)	16 (10)	0.9 (0.4 to 2.0)	6 (7.4)	1.5 (0.5 to 3.5)
BHR	305 (31.8)	75 (33.3)	14 (22.6)	0.6 (0.3 to 1.1)	11 (36.7)	1.2 (0.6 to 2.8)	78 (36.1)	1.2 (0.8 to 1.7)	29 (29.0)	0.9 (0.5 to 1.4)	28 (32.2)	39 (24.4)	0.7 (0.4 to 1.2)	13 (16.1)	1.3 (0.7 to 2.5)
Rhinitis	565 (58.8)	150 (66.7)	36 (58.1)	0.6 (0.4 to 1.2)	19 (63.3)	0.9 (0.4 to 2.1)	125 (57.8)	0.7 (0.5 to 1.0)	50 (50.0)	0.5 (0.3 to 0.8)	46 (52.9)	91 (56.9)	1.1 (0.7 to 2.0)	48 (59.3)	1.1 (0.6 to 2.0)
Conjunctivitis	199 (20.7)	47 (20.9)	18 (29.0)	1.6 (0.8 to 3.0)	8 (26.7)	1.4 (0.6 to 3.2)	39 (18.1)	0.9 (0.5 to 1.3)	31 (31.0)	1.7 (1.0 to 2.9)	12 (13.8)	26 (16.3)	1.2 (0.6 to 2.5)	18 (22.2)	1.8 (0.8 to 4.3)
Dermatitis	110 (11.5)	26 (11.6)	6 (9.7)	0.8 (0.3 to 2.1)	2 (6.7)	0.6 (0.1 to 2.6)	24 (11.1)	1.0 (0.5 to 1.8)	15 (15.0)	1.4 (0.7 to 2.9)	4 (4.6)	24 (15.0)	4.2 (1.5 to 14.0)	4 (4.9)	2.4 (1.7 to 8.5)

OR adjusted for gender, smoking status and farm childhood.
*Individually kept animals used as an internal reference group for subcategories of equine or companion animals.
†Animal husbandry used as an internal reference group for subcategories of animal husbandry+VPH or farm animals.
NA, not available; SOB, shortness of breath (asthma-like, wheezing or chest tightness); VPH, veterinary public health.

Table 3 Prevalence and adjusted ORs (95% CI) for newly self-reported allergy and related symptoms per study specialisation upon starting the veterinary medicine study program

		Individually kept animals										Farm animal health				
		Individually kept animals* Years 1–2 (n=225)	Equine				Companion animals				Animal husbandry† Years 1–2 (n=87)	Animal husbandry+VPH		Farm animals	
	Total (n=961)		Years 3–5 (n=62)		Year 6 (n=30)		Years 3–5 (n=216)		Year 6 (n=100)			Years 3–5 (n=160)		Year 6 (n=81)	
	n (%)	n (%)	n (%)	OR (95% CI)	n (%)	OR (95% CI)	n (%)	OR (95% CI)	n (%)	OR (95% CI)	n (%)	n (%)	OR (95% CI)	n (%)	OR (95% CI)
Allergy to various allergens	84 (8.7)	16 (7.1)	3 (4.8)	0.6 (0.2 to 2.3)	6 (20)	3.5 (1.2 to 10)	15 (6.9)	1.0 (0.5 to 2.0)	12 (12)	1.8 (0.8 to 3.9)	3 (3.4)	13 (8.1)	2.5 (0.7 to 8.9)	16 (20)	6.9 (1.9 to 25)
Allergy to animals	37 (3.9)	5 (2.2)	2 (3.2)	1.4 (0.3 to 7.5)	1 (3.3)	1.7 (0.2 to 15)	6 (2.8)	1.3 (0.4 to 4.4)	6 (6.0)	3.0 (0.9 to 10)	1 (1.2)	7 (4.4)	5.5 (0.6 to 47)	9 (11.1)	12 (1.4 to 103)
Breathing problem	15 (1.6)	3 (1.3)	1 (1.6)	1.1 (0.1 to 11)	1 (3.3)	2.2 (0.2 to 23)	2 (0.9)	0.7 (0.1 to 4.5)	3 (3.0)	2.5 (0.5 to 13)	NA	2 (1.3)	1.1‡	3 (3.7)	3.3‡
Sneezing or runny nose	22 (2.3)	4 (1.8)	2 (3.2)	1.8 (0.3 to 10)	1 (3.3)	1.9 (0.2 to 18)	1 (0.5)	0.3 (0.1 to 2.5)	4 (4.0)	2.5 (0.6 to 11)	NA	5 (3.1)	2.8‡	5 (6.2)	5.7‡
Itchy and red skin	20 (2.1)	1 (0.4)	NA	–	NA	–	5 (2.3)	5.3 (0.6 to 46)	4 (4.0)	9.3 (1.0 to 85)	1 (1.2)	4 (2.5)	2.5 (0.3 to 25)	5 (6.2)	5.4 (0.6 to 50)
Itching eyes	20 (2.1)	3 (1.3)	NA	–	NA	–	1 (0.5)	0.2 (0.0 to 2.4)	5 (5.0)	3.1 (0.6 to 15)	NA	5 (3.1)	2.8‡	6 (7.2)	6.9‡
Confirmed by blood or skin prick test	11 (1.1)	1 (0.4)	NA	–	NA	–	1 (0.5)	1.1 (0.1 to 18)	3 (3.0)	5.6 (0.6 to 56)	NA	3 (1.9)	1.7‡	3 (3.7)	3.3‡
Allergy to grass pollen	52 (5.4)	12 (5.3)	NA	–	4 (13.3)	2.7 (0.8 to 9.0)	9 (4.2)	0.8 (0.3 to 1.9)	7 (7.0)	1.4 (0.5 to 3.5)	2 (2.3)	7 (4.4)	1.9 (0.4 to 9.6)	11 (13.6)	6.7 (1.4 to 31)
Breathing problem	19 (2.0)	3 (1.3)	NA	–	3 (10.0)	8.2 (1.6 to 43)	6 (2.8)	2.1 (0.5 to 8.6)	2 (2.0)	1.5 (0.3 to 9.2)	NA	1 (0.6)	0.5‡	4 (4.9)	4.5‡
Sneezing or runny nose	45 (4.7)	11 (4.9)	NA	–	4 (13.3)	2.5 (0.7 to 8.7)	7 (3.2)	0.7 (0.2 to 1.7)	7 (7.0)	1.5 (0.6 to 3.9)	2 (2.3)	6 (3.8)	1.7 (0.3 to 8.4)	8 (10.0)	4.7 (1.0 to 23)
Itchy and red skin	2 (0.2)	1 (0.4)	NA	–	NA	–	1 (0.5)	1.0 (0.1 to 17)	NA	–	NA	NA	–	NA	–
Itching eyes	35 (3.6)	10 (4.4)	NA	–	3 (11.0)	2.4 (0.6 to 9.2)	7 (3.2)	0.7 (0.3 to 1.9)	2 (2.0)	0.4 (0.1 to 2.0)	2 (2.3)	5 (3.1)	1.4 (0.3 to 7.2)	6 (7.4)	3.4 (0.7 to 17)
Confirmed by blood or skin prick test	10 (1.0)	NA	NA	–	1 (3.3)	–	2 (0.9)	–	1 (1.0)	–	NA	3 (1.9)	1.6‡	3 (3.7)	3.3‡
Allergy to house dust	24 (2.5)	3 (1.3)	1 (1.6)	1.1 (0.1 to 11)	2 (6.7)	6.3 (1.0 to 41)	4 (1.9)	1.4 (0.3 to 6.6)	4 (4.0)	3.2 (0.7 to 15)	NA	5 (3.1)	2.8‡	5 (6.2)	5.7‡
Breathing problem	16 (1.7)	3 (1.3)	NA	–	2 (6.7)	6.1 (0.9 to 40)	3 (1.4)	1.1 (0.2 to 5.5)	3 (3.0)	2.4 (0.5 to 12)	NA	2 (1.3)	1.1‡	3 (3.7)	3.3‡
Sneezing or runny nose	21 (2.2)	2 (0.9)	NA	–	2 (6.7)	8.0 (1.1 to 59)	4 (1.9)	2.2 (0.4 to 12)	4 (4.0)	4.8 (0.9 to 27)	NA	4 (2.5)	2.2‡	5 (6.2)	5.7‡
Itchy and red skin	3 (0.3)	NA	1 (1.6)	–	NA	–	NA	–	1 (1.0)	–	NA	NA	–	1 (1.2)	1.1‡
Itching eyes	12 (1.3)	3 (1.3)	NA	–	2 (6.7)	6.1 (0.9 to 40)	1 (0.5)	0.4 (0.0 to 3.6)	2 (2.0)	1.6 (0.3 to 10)	NA	1 (0.6)	0.5‡	3 (3.7)	3.3‡
Confirmed by blood or skin prick test	17 (1.8)	1 (0.4)	1 (1.6)	3.5 (0.2 to 57)	1 (3.3)	8.9 (0.5 to 152)	2 (0.9)	2.2 (0.2 to 24)	4 (4.0)	9.8 (1.1 to 90)	NA	3 (1.9)	1.6‡	4 (4.9)	4.5‡

OR adjusted for sex, allergy, smoking status and farm childhood.
*Individually kept animals used as an internal reference group for subcategories of equine or companion animals.
†Animal husbandry used as an internal reference group for subcategories of animal husbandry+VPH or farm animals.
‡Estimate of the OR calculated by adding one person at the reference group.
–unable to calculate as no participants in the groups; NA, not available; VPH, veterinary public health.

Table 4 Prevalence and ORs (95% CI) for sensitisation against various allergens per study specialisation throughout the veterinary medicine study program

		Individually kept animals									Farm animal health				
		Individually kept animals* Years 1–2 (n=158)	Equine				Companion animals				Animal husbandry† Years 1–2 (n=63)	Animal husbandry+VPH		Farm animals	
	Total (n=673)		Years 3–5 (n=45)		Year 6 (n=12)		Years 3–5 (n=163)		Year 6 (n=53)			Years 3–5 n=128)		Year 6 (n=51)	
	n (%)	n (%)	n (%)	OR (95% CI)	n (%)	OR (95% CI)	n (%)	OR (95% CI)	n (%)	OR (95% CI)	n (%)	n (%)	OR (95% CI)	n (%)	OR (95% CI)
Common allergens															
House dust mite	87 (12.9)	18 (11.4)	11 (24.4)	2.7 (1.0 to 7.1)	3 (25.0)	1.8 (0.4 to 8.7)	17 (10.4)	0.9 (0.4 to 1.9)	6 (11.3)	1.0 (0.3 to 2.9)	13 (20.6)	16 (12.5)	0.7 (0.3 to 1.7)	3 (5.9)	0.2 (0.1 to 0.9)
Grass pollen	109 (16.2)	26 (16.5)	12 (26.7)	1.8 (0.8 to 4.5)	1 (8.3)	0.3 (0.0 to 2.3)	25 (15.3)	0.9 (0.5 to 1.8)	7 (12)	1.1 (0.4 to 2.6)	13 (20.6)	19 (14.8)	0.8 (0.3 to 1.8)	4 (7.8)	0.3 (0.1 to 1.0)
Birch pollen	23 (3.4)	8 (5.1)	2 (4.4)	0.8 (0.2 to 3.9)	1 (8.3)	1.2 (0.1 to 11)	5 (3.1)	0.6 (0.2 to 1.9)	1 (1.9)	0.4 (0.1 to 2.9)	3 (4.7)	2 (1.6)	0.3 (0.1 to 2.0)	1 (2.0)	0.4 (0.0 to 4.0)
Cat	28 (4.2)	7 (4.4)	2 (4.4)	1.0 (0.2 to 5.0)	NA	–	7 (4.2)	1.0 (0.3 to 3.0)	4 (7.6)	2.9 (0.5 to 7.5)	2 (3.2)	5 (3.9)	1.2 (0.2 to 6.6)	1 (2.0)	0.6 (0.1 to 7.0)
Dog	9 (1.3)	2 (1.3)	1 (2.2)	1.7 (0.2 to 20)	NA	–	7 (4.2)	2.0 (0.4 to 11)	1 (1.9)	1.5 (0.1 to 17)	NA	1 (0.8)	–	NA	–
Total	168 (25.0)	39 (24.7)	15 (33.3)	1.5 (0.6 to 3.6)	5 (41.6)	1.5 (0.4 to 6.6)	37 (22.7)	0.9 (0.5 to 1.7)	12 (22.6)	0.8 (0.3 to 2.0)	22 (34.9)	31 (24.2)	0.7 (0.3 to 1.5)	7 (13.7)	0.2 (0.1 to 0.6)
Laboratory and domestic animal allergens															
Rat (urine)	13 (1.9)	3 (1.9)	NA	–	NA	–	4 (2.5)	1.4 (0.3 to 6.5)	NA	–	1 (1.6)	5 (3.9)	2.5 (0.3 to 22)	NA	–
Mouse (urine)	19 (2.8)	3 (1.9)	1 (2.3)	1.1 (0.1 to 11)	1 (8.3)	4.2 (0.4 to 49)	7 (4.3)	2.5 (0.6 to 10)	1 (1.9)	0.9 (0.1 to 9.1)	2 (3.2)	4 (3.1)	1.0 (0.2 to 5.4)	NA	–
Budgerigar	21 (3.1)	7 (4.4)	1 (2.3)	0.4 (0.1 to 3.6)	NA	–	6 (3.9)	0.8 (0.3 to 2.5)	3 (5.7)	1.3 (0.3 to 5.0)	3 (4.8)	1 (0.8)	0.2 (0.0 to 1.5)	NA	–
Guinea pig	14 (2.1)	5 (3.2)	2 (4.6)	1.4 (0.3 to 7.7)	NA	–	3 (1.8)	0.6 (0.1 to 2.4)	NA	–	1 (1.6)	1 (0.8)	0.5 (0.0 to 7.8)	2 (3.9)	2.5 (0.2 to 28)
Total	56 (8.4)	14 (8.9)	4 (8.9)	1.0 (0.3 to 3.2)	1 (8.3)	0.8 (0.1 to 6.9)	15 (9.2)	1.0 (0.4 to 2.2)	4 (7.5)	0.8 (0.3 to 2.8)	7 (11.1)	9 (7.0)	0.6 (0.2 to 1.7)	2 (3.9)	0.3 (0.1 to 1.6)
Cat+dog	32 (4.8)	9 (5.7)	3 (6.6)	1.0 (0.2 to 4.3)	NA	–	8 (4.9)	0.9 (0.3 to 2.4)	4 (7.5)	1.4 (0.4 to 5.1)	2 (3.2)	5 (3.9)	1.2 (0.2 to 6.6)	1 (2.0)	0.6 (0.1 to 7.0)
Horse	11 (1.6)	3 (1.9)	2 (4.4)	2.4 (0.4 to 15)	1 (8.3)	4.7 (0.4 to 49)	4 (2.5)	1.0 (0.3 to 5.9)	1 (1.2)	1.0 (0.1 to 9.8)	NA	NA	–	NA	–
Farm occupational allergens															
Cow	25 (3.7)	3 (1.9)	1 (2.2)	1.2 (0.1 to 11)	NA	–	8 (4.9)	2.6 (0.6 to 10)	3 (5.7)	3.0 (0.6 to 16)	5 (7.9)	4 (3.1)	0.4 (0.1 to 1.7)	1 (2.0)	0.2 (0.0 to 2.1)
Goat	12 (1.8)	3 (1.9)	NA	–	NA	–	4 (2.5)	1.3 (0.3 to 5.9)	2 (3.8)	2.0 (0.3 to 12)	1 (1.6)	1 (0.8)	0.5 (0.0 to 7.9)	1 (2.0)	1.2 (0.1 to 20)
Pig (skin)	1 (0.2)	1 (0.6)	NA	–	NA	–	NA	–	NA	–	NA	NA	–	NA	–
Chicken	NA	NA	NA	–	NA	–	NA	–	NA	–	NA	NA	–	NA	–
Total	29 (4.3)	5 (3.2)	1 (2.2)	0.7 (0.1 to 6.3)	NA	–	9 (5.5)	1.8 (0.6 to 5.6)	3 (5.6)	1.9 (0.4 to 8.2)	5 (7.9)	4 (3.1)	0.4 (0.1 to 1.7)	2 (3.9)	0.5 (0.1 to 2.7)
Total (sensitisation)	222 (33.1)	51 (32.5)	18 (40.9)	1.4 (0.6 to 3.1)	6 (50.0)	1.7 (0.4 to 6.7)	55 (33.7)	1.1 (0.7 to 1.9)	18 (34.0)	1.1 (0.5 to 2.2)	28 (45.2)	37 (28.9)	0.5 (0.3 to 1.1)	9 (17.7)	0.2 (0.1 to 0.5)

*Individually kept animals used as an internal reference group for subcategories of equine or companion animals.
†Animal husbandry used as an internal reference group for subcategories of animal husbandry+VPH or farm animals.
–, unable to calculate as no participants in the groups; NA, not available; VPH, veterinary public health.

incidence, which has been reported for laboratory animal sensitisation.[21] This seems a plausible estimate though, because participants in the early years of their education are involved more in theoretical courses and consequently less in practical work; thus, the exposure intensity and exposure frequency is probably too low to induce the development of allergic symptoms in early years.

We used study specialisation groups as a surrogate of exposure and observed that the prevalence of self-reported symptoms of allergy was elevated in later years, but the onset of self-reported symptoms based on different study specialisation groups was variable. Handling farm animals emerged as the strongest risk factor for self-reported allergic symptoms to animals (11.1%). This risk is lower than the 20% risk of laboratory animal allergy among laboratory workers reported by a review study,[5] suggesting that those participants without allergy at the end of their education might still remain at a high risk of developing allergy in their future career.

The widespread symptoms of sneezing or runny nose (59.4%) among those with self-reported allergic symptoms to animals are in line with previously reported symptoms in Californian veterinarians (62%)[7] and also similar to the figure reported for swine veterinarians (69%).[10] Symptoms of itchy and red skin attributed to animals were less likely to occur (2.3%) similarly as reported for Californian veterinarians (11%).[7] The comparison should be interpreted with caution as we only included new-onset symptoms compared with the overall prevalence in the Californian study. The animals that were most commonly implicated in causing itchy and red skin were farm animals, followed by cat and dog. These findings are consistent with those reported earlier by Susitaival *et al*.[7] Dermatitis might partially occur due to contact with animal dander resulting in urticaria.[22] Urticaria derived from cow dander has been reported as a major cause of occupational dermatitis among veterinarians before. Furthermore, dermatitis could be partially associated with the use of gloves[13] and antibiotics.[23]

The allergy prevalence noticeably differs whether derived by questionnaire or serological assessment.[5] A high number of participants with newly self-reported allergic symptoms without evidence of positive IgE are in line with what has been reported previously.[16 19] Veterinarians are very likely exposed to proinflammatory agents such as bacterial endotoxin and fungal β-(1–3)glucan, as well as irritant agents such as ammonia and disinfectants in animal houses.[1 2 24] Therefore, it is reasonable to assume that reported allergic symptoms without IgE could also be caused by these agents and thus might be mediated through other than type II allergic mechanisms. We also found a substantial number of sensitised individuals (38.3%) without self-reported symptoms of allergy, either before or after starting veterinary medicine study. This observation is in agreement with a previous study.[19] However, sensitised participants without any symptoms are known to be more prone to develop symptoms in the near future.[25]

In the present study, cat sensitisation was the most prevalent animal sensitisation (4.2%), with a lower sensitisation risk for dog (1.3%). The pattern of sensitisation to cat is known to be inconsistent among cat owners in comparison with those people without having cat.[26] In contrast to cat owners, sensitisation risk for dog is consistently reduced among dog owners.[26] Although most animals treated in the companion animal hospital were dogs (≥95%) and, to a lesser extent, cats (<5%), less sensitisation to dogs and more sensitisation to cats in the present study support earlier studies and might probably reflect previous contacts with cats and dogs since 97% of the study population had previous contact with cats and/or dogs.

We found an inverse risk of sensitisation in the study specialisations of animal husbandry (years 3–5) and farm animals (year 6) compared with the reference group, while the prevalence of self-reported symptoms was elevated. Previous studies described tolerance associated with IgG and IgG4 antibody responses to animal allergens,[27 28] consequently specific IgE antibodies against animal allergens could not be detected. However, a longitudinal study is needed to investigate the relationship between exposure to specific animal allergens and risk of sensitisation.

Several important limitations of this study need to be considered. Two of the participants in this study changed study specialisation during the course of their education because they had been seriously affected by allergy. This might be an underestimation because participants with allergy that completely end their education might not be included.[29] Most of the participants in this study have had previous and/or current contact with animals, especially domestic animals, besides the study program. As a result, it is difficult to distinguish between the exposure to animals through the study program and the exposure outside the study program in association with the development of allergy.

Participation bias needs to be considered. Although participants with a history of allergy more likely provided a blood sample than those without a history of allergy, this suggests a possible source of bias in the sensitisation part of this cross-sectional study. However, as the relative number of participants with history of allergy who provided a blood sample was the same for the different study durations, the association between sensitisation and study over time is not affected. For some specialisation groups, the number of participants sensitised or reporting allergic symptoms was low, limiting our ability to estimate associations over time. The self-reported time course of symptoms might be a source of bias as well due to misclassification of the time of initiation of symptoms. How this would have affected the outcomes cannot be said.

However, known factors previously associated with enhanced or decreased sensitisation such as enhanced total IgE and growing up on a farm behaved similarly in the current study. Enhanced total IgE ≥100 kU/l was strongly associated with sensitisation as in other studies demonstrating enhanced total IgE as a strong determinant for sensitisation.[19 21 30] Farm childhood exposure was associated with a reduced risk of self-reported allergy or sensitisation in adulthood. There is consistent evidence for this finding as illustrated for French farmers,[31] Danish farmers[32] and Dutch farmers.[33] This suggests that veterinary medicine students with an earlier exposure to farm environments might be protected from developing allergy, although current farm animal exposure still is associated with an increased risk to report respiratory symptoms. A similar paradoxical finding had been reported for Dutch agricultural population previously.[33]

CONCLUSIONS

The findings of this study provide evidence of an increased prevalence of (allergic) symptoms with elevated years of veterinary study, proposing that contact with animals, more specifically contact to farm animals, is a risk factor for developing symptoms. There is still a need for further investigation to determine the incidence of sensitisation and allergic symptoms in a follow-up study and also to find out a dose–response relationship between bioaerosol exposure and health outcomes.

Acknowledgements We are grateful to all participants. We thank Lützen Portengen for advice on data analysis, as well as Manon Bogaerts and Lot Bannink for their assistance in data collection.

Competing interests None.

Patient consent Obtained.

Ethics approval This study was conducted with the approval of the ethical committee of the Utrecht University (record number 06/076).

Provenance and peer review Not commissioned; externally peer reviewed.

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Allergy among veterinary medicine students in The Netherlands

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Occup Environ Med 2012 69: 48-55 originally published online May 31, 2011
doi: 10.1136/oem.2010.064089