Canine atopic dermatitis in the Middle East: clinical signs, signalment and common allergens

G. Zur[1], I. Skorinsky[2], T. Bdolah-Abram[1]

[1]The Veterinary Teaching Hospital, Koret School of Veterinary Medicine, The Hebrew University of Jerusalem, Rehovot, Israel
[2]Monosson VetDerm Referrals, Monosson, Israel

ABSTRACT: The aim of the study was to examine for the first time the various aspects of canine atopic dermatitis (CAD) presenting in a Middle Eastern country. Medical records of 164 dogs diagnosed with CAD were evaluated. Associations between signalment, lifestyle, clinical signs and allergens were evaluated statistically. Labrador Retriever, German Shepherd dog, Boxer, French Bulldog, Golden Retriever and Shar-Pei breeds were presented more frequently than the regular hospital population ($P < 0.0001$), and had an earlier disease onset time ($P < 0.01$). In 22 dogs (13%) signs of CAD were noticed at less than six months of age. Most dogs (75%) lived indoors. Most dogs (83%) had lesions on the ventral part of the body and 68% had foot lesions. After excluding flea allergy dermatitis by implementing strict flea control, 60% of the dogs presented with dorsal distribution of skin lesions. Dogs with ventral lesions were younger when clinical signs first appeared ($P < 0.05$). Most of the dogs were allergic to dust and/or dust mites (75.6%), with weeds and trees as the next most common allergens. CAD is similar worldwide, but geographic differences may be attributable to genetic pools and allergen loading. This study also shows that early onset of clinical signs, especially in breeds predisposed to CAD and with a dorsal distribution of skin lesions, should not rule out the diagnosis of CAD.

Keywords: dog; allergies; skin lesions; *otitis externa*

List of abbreviations

CAD – canine atopic dermatitis, **FAD** – flea allergy dermatitis, **IDT** – intra-dermal test, **GSD** – German shepherd dog

Canine atopic dermatitis (CAD) is defined as the clinical presentation of skin disease in dogs that exhibit an inherited tendency to develop IgE antibodies and specific allergic mediators in response to exposure to environmental allergens (Reedy et al. 1997; Scott et al. 2001; Halliwell, 2006). It occurs in 3–15% of canine populations (Reedy et al. 1997; Scott et al. 2001). The disease is manifested by pruritus beginning at a young age with lesions on the face, extremities, axillae or ventrum (Willemse, 1986; Griffin and DeBoer, 2001; Scott et al. 2001; Favrot et al. 2010). CAD is difficult to diagnose because there is no specific diagnostic test or pathognomonic sign; rather, diagnosis is based on meeting certain criteria and eliminating other pruritic diseases (Willemse, 1986; Reedy et al. 1997; Griffin and DeBoer, 2001; Scott et al. 2001; Favrot et al. 2010). Published studies have described the disease in various continents and countries (Saridomichelakis et al. 1999; Masuda et al. 2000; Mueller et al. 2000; Youn et al. 2002; Zur et al. 2002; Tarpataki et al. 2006; Nodtvedt et al. 2007; Picco et al. 2008). However, the multiple aspects and presentations of the disease in the Middle East have not been reported, and the aim of this study is to describe CAD as well as the common environmental allergens associated with affected dogs in this part of the world.

MATERIAL AND METHODS

Study animals

Medical records of 164 dogs that met the following inclusion and exclusion criteria were evaluated retrospectively. Inclusion criteria were dogs admitted to the dermatology department of a teaching hospital and to a principal dermatology referral clinic located near the teaching hospital between the years of 1995 to 2006. Only dogs diagnosed with CAD according to Willemse's major and minor criteria (Willemse 1986), and having at least two positive results (+2.5 and above) on intra-dermal allergy tests (IDT) were included. Sarcoptic mange was excluded by lack of response to six doses of ivermectin (Ivomec; Merck, Haarlem, Holland) 250 µg/kg body weight given once a week. Adverse reaction to food was excluded by a lack of response (decrease of pruritus) to an elimination dietary trial lasting at least eight weeks. Exclusion criteria included dogs diagnosed with an adverse reaction to food, and dogs diagnosed with flea allergic dermatitis (FAD) by clinical signs and/or response to strict flea control (e.g imidacloprid (Advantage; Bayer, Kien, Germany) spot-on or fipronil (Frontline; Merial, France) spot-on or spray application every three to four weeks to all pets in the household in addition

Table 1. Allergens examined in this study according to group

Dust and dust mites	**Bush pollens**
Dermatophagoides pteronyssinus	Russian Thistle *Salsola pestifer*
D. farinae	Sage *Artemisia* spp.
House dust	English Plantain *Plantago lanceolata*
Tree pollens	Rose *Rosa* spp.
Pecan *Carya* spp.	Red Juniper *Juniperus virginiana*
Olive *Olea europea*	**Moulds**
Cypress *Cupressus* spp.	*Mucor* mix
Pine *Pinus* spp.	*Aspergillus niger*
Palm *Cocos plumose*	*Pullularia pullulans*
Eucalyptus *Eucolyptus globulus*	*Penicillium* mix
Oak *Quercus* spp.	*Fusarium moniliforme*
Orange *Citrus sinensis*	*Hormodendrum hordei*
Birch *Betula* spp.	*Curvularia specifera*
Beech *Fagus* spp.	*Alternaria tenius*
Red Mulberry *Morus rubra*	*Monilia candida*
Black Willow *Salix nigra*	*Cladosporium*
Weeds, Grasses pollens	*Cephalosporium*
Orchard *Dactylis glomerata*	*Stemphylium*
Perennial Rye *Lolium perenne*	*Botrytis cinerea*
Bermuda *Cynodon dactylon*	**Insects**
Johnson *Sorghum halepense*	House fly *Musca domestica*
Ryegrass *Lolium* spp.	Black ant *Camponotus pennsylvanica*
Bahia grass *Paspalum notatum*	Mosquito *Culicidae* spp.
Nettle *Urtica* spp.	Flea *Ctenocephalides felis**
Rough Pigweed *Amaranthus retroflexus*	**Miscellaneous***
Clover *Trifolium* spp.	Cat epithelium
Western Ragweed *Ambrosia psilostachya*	Dog epithelium
Alfalfa *Medicago sativa*	Mixed feathers
Sunflower *Helianthus* spp.	Pyrethrum
Dandelion *Taraxacum officinale*	Cotton seeds

*examined individually

to environmental preventive treatment). Dogs with bacterial or yeast dermatitis that fully responded to antibiotics or anti-yeast treatment, respectively, were excluded. Dogs lacking three or more details regarding signalment, habitat and skin lesion data were also excluded. All the IDTs were performed by one of the two first authors according to standard methods (Schick and Fadok 1986; Willemse 1986; Hillier and DeBoer 2001; Scott et al. 2001). All the allergens were obtained from Greer Laboratories (Lenoir, NC, USA). A list of allergens is given in Table 1.

Collected data

The following data were collected from medical records: signalment (including breed, gender, age of onset of the disease and age of test); lifestyle: indoor or outdoor habitat, geographical location and presence of another pet in the household; distribution of skin lesions and the allergens detected on IDT.

Breeds were assessed and compared with the general hospital population over the studied period. Associations between different groups of allergens and various parameters of signalment, habitat and skin lesions were examined.

Statistical analysis

Data processing. The allergens were grouped for statistical analysis (Table 1). The scoring of IDT results was categorised as follows: 0 and 1 = 1; 1.5 to 2 = 2; 2.5 and up = 3.

Statistical analysis of the allergens was performed twice: once, considering the highest degree of positivity in a group for the whole group as one unit (for example, if one weed was graded 3, and the other weeds 3 or less then the whole group of weeds was graded 3), and a second time, considering the mean score of all members in a group as the score for the group (for example if four different weeds were tested and had scores of 1, 2, 2 and 3, then the score of the group was 2).

Distribution of skin lesions was divided into five categories: ventrum, including ventral abdomen and chest, inguinal area, axillae and ventral neck; dorsum, which included the back, dorso-lumbar area, lateral thigh and lateral fore-limbs, dorsal neck and back of the head; face, including the periaural, periorbital and muzzle; feet, including the distal part of the legs, interdigital areas and paw-pads; *otitis externa* – including ear canals and pinnae.

Geographical area was divided into three parts: north, centre and south. East was included in the central part of the country.

Statistical tests. Chi-square and Fisher's exact tests were applied for assessing the associations between two categorical variables. This included testing the associations between allergens and breeds, gender, anatomical distribution of lesions and lifestyle details (geographical area, in/outdoors and having another pet in the household); between the various signalments, lesions and environmental parameters and between the breeds in the study and identical breeds in the hospital population. The Kruskal-Wallis analysis of variance was used to compare the ages of onset and tests with the allergens and the other parameters. This test was also applied when comparing the percentage of positive reactions in each group of allergens with the following parameters: breed, geographical area, in/outdoors. The Mann-Whitney non-parametric test was applied when associations between the percentages of allergens and parameters of gender, distribution of lesions and another pet in the household were examined. This test was also used to examine possible associations between ages of onset and test with distribution of lesions.

All tests applied were two-tailed and a P-value of 5% or less was considered statistically significant.

Analyses were carried out using the SPSS statistical software (PASW statistics 17, 2010).

RESULTS

Signalment and lifestyle of dogs with CAD

Eighty eight females and 76 males were studied. The most common breeds were: Labrador Retriever (17 dogs, 10.4%), German Shepherd dog (GSD) (17 dogs, 10.4%), Boxer (16 dogs, 9.7%), French Bulldog (12 dogs, 7.3%), Golden Retriever (11 dogs, 6.7%) and Shar-Pei (7 dogs, 4.3%), in this order of frequency. These breeds were presented significantly more than the regular hospital population admitted during part (three years) of the same time period ($P < 0.0001$).

The median age of appearance of clinical signs was 12 months (range three to 117 months, mean 23.32, SD 26.2). In 22 dogs the owners observed

Table 2. Age of appearance of clinical signs

Breed (number of dogs)	Age of appearance of clinical signs (in months)		
	mean	median*	SD
Labrador Retriever (17)	10.00	7.00	7.42
German Shepherd (17)	23.92	12.00	26.42
Boxer (16)	16.82	6.00	22.69
French Bulldog (12)	11.30	6.00	14.94
Golden Retriever (11)	9.63	6.50	10.90
Shar-Pei (7)	18.86	7.00	22.00
Other breeds (54)	29.80	16.00	29.35
Mix breeds (30)	36.00	24.00	31.96

*Kruskal-Wallis test exhibited significant difference between the six groups of pure-breed and the two groups of other- and mix-breed ($P < 0.01$)

clinical signs earlier than six months of age and in seven dogs they did not notice clinical signs before the age of six years. The median age at which the dogs were tested was 36 months (ranging from 12 to 144 months, mean 42.47, SD 31.1).

The breeds most commonly affected with CAD (Labrador and Golden Retrievers, Boxer, French Bulldog and Shar-Pei) showed clinical signs at a statistically significant younger age than the other breeds and mix-breed dogs ($P < 0.01$) (median of six to seven months *vs* 16 and 24 months for the other breeds and mix-breeds respectively (Table 2).

The majority of the dogs lived mostly indoors (123 dogs, 75%), and only less than 10% of the study population (9.7%) lived strictly outdoors. The rest (25 dogs) spent approximately the same time in- and outdoors.

Most of the dogs (116, 71%) lived in the centre of the country. Thirty two dogs lived in the north (19.5%) and 16 dogs lived in the south.

Most of the dogs (125, 76%) were the only pet in their household.

Distribution of skin lesions of dogs with CAD

Most of the dogs (136, 82.9%) had lesions on the ventral part of the body. Sixty eight percent (67.7%) (111 dogs) had lesions on their feet and in 100 dogs (61%), the dorsum was also affected. Lesions and/or facial pruritus were observed in 41% (67 dogs) of the dogs. *Otitis externa* was diagnosed in 81 dogs (49.4%).

Associations between signalment, lifestyle and skin lesions in dogs with CAD

Dogs with lesions on the ventral part of the body were younger than dogs with lesions at other sites when clinical signs first appeared, with a median age of 10 months ($P < 0.05$).

Only one dog that lived entirely outdoors had *otitis externa* ($P < 0.01$), and only two had facial lesions ($P < 0.05$), out of 10% of the dogs that lived outdoors.

For all the other parameters examined there were no differences between the dogs in the study.

Allergens in dogs with CAD

Most of the dogs were allergic to dust and/or dust mites (144 dogs, 75.6%), with weeds and trees as the next most common allergens. The least common allergens were feathers, dog epithelia and cotton (Table 3).

Associations between allergens, signalment and lifestyle (Table 4)

For most of the allergens examined, there were no differences between the various breeds, age of onset or age when the test was performed, or between males and females.

The Golden Retrievers, Boxers, Shar-Peis and mix breed dogs had statistically significant higher percentages of positive reactions to tree allergens than the other breeds ($P < 0.05$).

Table 3. Intra dermal tests (IDT) results

Allergen group	Allergen – levels – number of dogs in each level			Allergens – percentage positive (level 2.5 and up) in the group		
	1 (0–1)	2 (1.5–2)	3 (2.5 and up)	mean	median	SD
Dust	22	18	124	62.81	75.00	41.31
Insects	46	55	63	17.70	0.00	25.25
Moulds	14	72	78	6.17	0.00	9.72
Weeds	10	51	103	13.45	9.10	17.69
Bush	29	70	65	13.45	0.00	21.10
Trees	19	59	86	10.82	8.33	16.52
Individual allergens	Allergen – levels – number of dogs in each level (percentage positive)					
Flea	99	34	31 (18.9%)			
Feather mix	119	39	6 (4.5%)			
Cat epithelium	66	70	28 (17.1%)			
Dog epithelium	89	61	14 (8.5%)			
Cotton seeds*	64	44	13 (10.7%)			
pyrethrum	69	49	18 (13.2%)			

For groups' details see Table 1

*43 dogs were not tested for cotton seeds

Females had more positive reactions to fleas ($P < 0.05$).

No differences were found in the positive reactions to the various allergens with regard to whether the dogs lived indoors or outdoors, whether there was another pet in the household, or in what part of the country they lived.

Associations between allergens and skin lesions (Table 4)

Only 20% of dogs with positive reactions to flea allergens had lesions on their dorsum.

Among the dogs with *otitis externa*, only one was positive to feathers ($P < 0.05$), while they tended to have a higher percentage of positive reactions to moulds ($P < 0.1$) than at other sights of skin lesions. Dogs with *otitis externa* had a higher percentage response to dust than to other allergens ($P < 0.05$).

DISCUSSION

This is the first report from the Middle East describing the features of CAD. The study was conducted at two referral centres, and one of them (the teaching hospital) also occasionally received cases from neighbouring countries. Canine atopic dermatitis is a very common skin disease, but there is no objective diagnostic test for its confirmation. Recently, new criteria for its diagnosis were established which have a high specificity but are not highly sensitive (Favrot et al. 2010). The dogs reported here had been diagnosed with CAD prior to the publication of these new criteria and all had positive allergy tests. For most of the examined parameters these dogs resembled those in other reports of CAD and satisfied the new criteria. However, some differences between the new criteria and the results of this study emerged. In particular, these included an earlier age of onset of clinical signs and the wider distribution of skin lesions that also included lesions on the dorsum.

Signalment of dogs with CAD

The breeds with the highest predilection for CAD in this study (Labrador Retriever, German Shepherd dog, Boxer, French Bulldog, Golden Retriever) were the ones which most commonly presented with CAD in a recent study that included the new diagnostic criteria. Nevertheless, belonging to one of these

Table 4. Percentages of positive dogs to allergens (individuals or as a group). Median positives for groups (mean ± SD) according to signalment, lifestyle and site of lesions

		Allergen										
		flea	feather	cat epithelium	dog epithelium	cotton seed	dust	insect	moulds	weed	bush	tree
Breed	mix	17.9	0.0	10.7	7.1	19.0	100.0 (69.0 ± 41.0)	0.0 (19.0 ± 23.0)	0.0 (3.6 ± 6.4)	12.5 (15.5 ± 16.6)	0.0 (12.9 ± 24.4)	8.3 (12.2 ± 20.3)[c]
	other	17.6	9.8	23.5	2.0	10.0	50.0 (60.8 ± 41.6)	0.0 (20.9 ± 29.0)	9.1 (5.0 ± 7.3)	10.0 (10.0 ± 12.4)	12.3 (12.3 ± 16.0)	0.0 (7.3 ± 10.9)
	Golden Retriever	10.0	0.0	30.0	10.0	12.5	50.0 (50.0 ± 47.1)	16.7 (16.7 ± 17.6)	0.0 (3.8 ± 7.5)	18.2 (22.5 ± 20.5)	10.0 (24.5 ± 29.3)	11.1 (25.6 ± 26.3)[c]
	Labrador Retriever	20.0	0.0	33.3	21.4	0.0	50.0 (43.7 ± 44.2)	0.0 (14.6 ± 24.2)	7.7 (12.8 ± 17.6)	4.5 (9.1 ± 12.0)	0.0 (11.6 ± 18.0)	0.0 (9.2 ± 11.0)
	GSD	33.3	0.0	12.5	0.0	8.3	100.0 (84.4 ± 30.1)	0.0 (8.9 ± 19.8)	7.7 (8.2 ± 11.4)	4.5 (9.7 ± 13.2)	0.0 (9.1 ± 14.9)	0.0 (6.2 ± 13.1)
	French Bulldog	9.1	0.0	9.1	27.3	16.7	50.0 (50.0 ± 44.7)	0.0 (15.1 ± 27.3)	0.0 (6.3 ± 8.3)	0.0 (8.3 ± 14.9)	0.0 (1.4 ± 16.7)	0.0 (7.3 ± 9.7)
	Boxer	13.3	0.0	6.7	20.0	18.2	50.0 (66.7 ± 36.2)	0.0 (20.0 ± 30.3)	0.0 (9.2 ± 11.7)	9.1 (16.9 ± 27.7)	0.0 (14.0 ± 27.7)	8.3 (14.1 ± 18.1) [c]
	Shar-Pei	42.9	0.0	14.3	14.3	0.0	50.0 (64.3 ± 37.8)	0.0 (14.3 ± 26.2)	7.7 (5.5 ± 5.8)	18.2 (26.0 ± 27.0)	0.0 (8.6 ± 15.7)	8.3 (11.9 ± 10.6)[c]
Sex	male	17.8[a]	4.1	20.5	9.7	7.0	50.0 (58.9 ± 41.1)	0.0 (15.5 ± 23.0)	0.0 (5.2 ± 8.7)	9.1 (13.2 ± 16.1)	0.0 (11.4 ± 18.7)	8.3 (9.8 ± 13.1)
	female	21.4[a]	3.5	15.3	8.3	14.8	100.0 (66.7 ± 40.2)	0.0 (19.6 ± 27.3)	3.8 (7.2 ± 10.6)	9.1 (13.0 ± 17.9)	0.0 (14.0 ± 21.0)	0.0 (10.8 ± 17.4)
Distribution of lesions	ventral	20.2	3.4	16.7	8.4	9.2	50.0 (61.4 ± 42.3)	0.0 (17.9 ± 25.6)	0.0 (5.8 ± 8.2)	9.1 (12.6 ± 15.4)	0.0 (13.0 ± 20.0)	8.3 (10.3 ± 15.7)
	dorsal	19.8	3.4	16.1	9.4	13.1	50.0 (62.4 ± 41.5)	0.0 (15.3 ± 23.2)	0.0 (7.0 ± 10.7)	9.1 (11.7 ± 19.1)	0.0 (11.1 ± 19.1)	8.3 (9.2 ± 14. 0)
	otitis externa	27.1	1.4[b]	15.7	7.2	11.3	50.0 (54.9 ± 42.1)[d]	0.0 (19.2 ± 27.4)	7.7 (7.6 ± 11.0)	9.1 (12.8 ± 14.7)	0.0 (12.8 ± 19.8)	8.3 (11.3 ± 17.5)
	face	22.0	0.0	16.9	12.3	10.0	50.0 (60.8 ± 41.3)	0.0 (15.5 ± 24.9)	0.0 (8.0 ± 12.6)	9.1 (12.3 ± 17.4)	0.0 (12.1 ± 18.7)	0.0 (8.4 ± 11.3)
	feet	19.4	3.1	19.4	9.4	8.6	100.0 (64.6 ± 39.9)	0.0 (18.0 ± 24.0)	0.0 (5.6 ± 8.5)	9.1 (12.0 ± 14.6)	0.0 (12.8 ± 19.6)	8.3 (9.6 ± 14.5)
Geographical area	north	16.1	6.5	16.1	12.9	23.1	75.0 (64.0 ± 40.6)	0.0 (15.0 ± 24.1)	0.0 (6.2 ± 8.3)	9.1 (15.6 ± 18.7)	0.0 (14.5 ± 23.7)	8.3 (14.1 ± 19.3)
	center	22.1	3.8	19.0	7.8	6.8	100.0 (65.1 ± 40.9)	0.0 (19.0 ± 25.7)	0.0 (6.2 ± 10.4)	9.1 (12.5 ± 16.6)	0.0 (12.3 ± 19.4)	0.0 (9.3 ± 15.1)
	south	16.7	0.0	8.3	8.3	11.1	50.0 (37.5 ± 37.7)	0.0 (19.4 ± 33.2)	11.5 (10.2 ± 10.0)	9.1 (11.4 ± 13.5)	20.0 (18.7 ± 20.0)	8.3 (9.3 ± 9.0)

Table 4 continued

		Allergen										
		flea	feather	cat epithelium	dog epithelium	cotton seed	dust	insect	moulds	weed	bush	tree
Habitat	indoors	19.8	3.7	14.2	7.7	9.2	50 (59.7 ± 40.1)	0.0 (16.5 ± 24.0)	0.0 (6.3 ± 10.3)	9.1 (13.2 ± 16.6)	0.0 (13.0 ± 19.9)	8.3 (10.2 ± 16.0)
	outdoors	20.0	10.0	20.0	10.0	25.0	100.0 (70.0 ± 58.3)	0.0 (23.3 ± 48.3)	7.7 (6.9 ± 7.6)	9.1 (13.7 ± 11.8)	10.0 (15.5 ± 19.6)	8.3 (6.7 ± 7.6)
	in-and out-doors	20.0	4.0	26.9	2.8	11.	100.0 (69.2 ± 42.6)	0.0 (21.3 ± 27.0)	0.0 (5.9 ± 8.2)	9.1 (8.8 ± 10.4)	0.0 (11.0 ± 17.3)	4.2 (9.9 ± 13.0)
	another pet	13.9	5.6	13.9	11.4	7.1	100.0 (65.3 ± 41.1)	0.0 (16.7 ± 21.8)	7.7 (8.1 ± 8.8)	9.1 (13.0 ± 14.9)	0.0 (13.1 ± 18.1)	8.3 (13.0 ± 16.6)

[a]chi-square exhibited difference between males and females in positive reactions for flea allergens $P < 0.05$

[b]Fischer-exact test showed that dogs with otitis externa were less allergic to feathers than to other allergens $P < 0.05$

[c]Kruskal-Wallis test revealed significant difference between golden retriever, boxers, shar-peis and mix breeds that had more positive reactions to trees than other breeds $P < 0.05$

[d]Mann-Witney test showed that dogs that with *otitis externa* had more positive reactions to dust than to other allergens $P < 0.05$

breeds was not a parameter for inclusion in the new criteria (Favrot et al. 2010). The Labrador Retriever and the Golden Retriever were found to have a very high predilection for CAD in several studies from North America, Europe and Australia (Zur et al. 2002; Nodtvedt et al. 2007; Jaeger et al. 2010). These breeds showed a strong heritability for the disease (Shaw et al. 2004). Interestingly, in Greece, a country that is closest geographically to the present study location, only the Chinese Shar-Peis showed a similar predilection (Saridomichelakis et al. 1999). We compared the breeds with the hospital population register but not with those from the private referral clinic. Theoretically, this could have influenced our results, although the very high significance implies that these results are valid. Furthermore, there is no indication that different veterinary centres in the same area have extremely different distributions of dog breeds. The age of appearance of clinical signs was similar to previous reports (DeBoer and Hillier, 2001; Scott et al. 2001; Zur et al. 2002), and the median age, 12 months, was identical to that from Sweden (Nodtvedt et al. 2006). Interestingly, in 22 records the age of onset of the disease was less than six months, which is earlier than the previously reported criteria (DeBoer and Hillier, 2001; Favrot et al. 2010). The breeds predisposed to CAD exhibited clinical signs significantly earlier as was also found in the case of Labrador Retrievers, Golden Retrievers and their crosses (Fraser et al. 2008). In a survey from Switzerland, the predisposed breeds were older at onset than in this study (Picco et al. 2008). Most of the dogs lived indoors and very few lived strictly outdoors. This was first reported in a survey of CAD in Hungary (Tarpataki et al. 2006) and was recently included in the new criteria by Favrot et al. (2010). Most of the dogs lived in the centre of the country, which is mostly urban. This parameter could have influenced the results, but the very pronounced differences between the in- and outdoor dogs override the issue of domesticity.

Lesions of dogs with CAD

In this study, skin lesions on the ventral part of the body occurred most commonly and they also started earlier. Although less frequent than those on the ventrum, lesions on the feet were also very common in the studied population. Feet lesions were

documented as the most common site in many other surveys from Europe, North America, Australia and Asia (Saridomichelakis et al. 1999; Zur et al. 2002; Chanthick et al. 2008; Jaeger et al. 2010), and recently they were also considered as a validating criterion for the diagnosis of CAD (Favrot et al. 2010). In this report, lesions on the ear pinnae, but not pinnal margins were also a validating criterion for CAD. This is of interest because in previous reports *otitis externa* had been considered as an important feature of CAD (Muse et al. 1996; Scott et al. 2001; Zur et al. 2002), and CAD was considered as one of the most common causes for *otitis externa* (Rosser 2004). In our study *otitis externa* was found in 49% of the dogs. Very similar findings were recently reported in surveys from five locations on three continents (Jaeger et al. 2010) and also to other studies from Greece and Switzerland (Saridomichelakis et al. 1999; Picco et al. 2008).

In this report no association between the various breeds and the occurrence of *otitis externa* was demonstrated. In a survey from Northern California, otitis was present in 60% of the atopic dogs, with Dalmatians at greater risk and mix breeds with the least risk (Zur et al. 2002). *Otitis externa* was the most frequent clinical sign in atopic Labradors and Golden Retrievers and their crosses in another study (Fraser et al. 2008). In a survey on dogs with CAD from three continents, Beagles, French Bulldogs, GSDs and Jack Russell terriers with *otitis externa* were presented significantly more (Jaeger et al. 2010). In another recent study boxers were reported to be highly affected with otitis (Wilhem et al. 2011).

Dogs with FAD were not included in this study; nonetheless, more than 60% had lesions on the dorsum. Dorsal distribution is not a feature of CAD, and it is stated that one of the inclusion criteria for CAD is an unaffected dorso-lumbar area (Favrot et al. 2010). Skin lesions in dogs in this study did not respond to strict flea control. It is possible that in areas endemic for fleas the strict flea control that had been practiced by the owners was not effective enough and some dogs still had FAD concurrently with CAD. In another endemic area in Northern California FAD was diagnosed concurrently in 50% of the dogs with atopic dermatitis (Zur et al. 2002). In a survey of CAD in Switzerland, a flea non-endemic country, 15% of the dogs had dorso-lumbar skin lesions (Picco et al. 2008). These findings suggest that dorso-lumbar distribution of skin lesions can frequently be present in dogs with CAD.

Our data did not show any associations between breeds and the distribution of the other lesions of CAD, however, such associations have been reported (Picco et al. 2008; Jaeger et al. 2010; Wilhem et al. 2011). The clinical significance of these findings is unclear, however, and none of these associations was included in the new criteria for the diagnosis of CAD (Favrot et al. 2010).

Allergens in dogs with CAD and their associations with signalment, lifestyle and distribution of skin lesions

Comparisons of various allergens are problematic due to the lack of standardisation in different studies (Hill and DeBoer 2001). In the present study we tried to overcome the inter-study variation by including only dogs that were allergy-tested by IDT. All allergens were purchased from one company and all the tests were performed by one of the first two authors. However, during the 12 years period of the study individual allergens were changed. To overcome this problem, the allergens were grouped and statistical analysis was performed on the group. As in almost all the reported surveys of CAD, house dust and house dust mites were the most common allergens in the studied populations (Saridomichelakis et al. 1999; Masuda et al. 2000; Mueller et al. 2000; Hill and DeBoer 2001; Bensignor and Carlotti, 2002; Youn et al. 2002; Zur et al. 2002; Nodtvedt et al. 2006; Tarpataki et al. 2006; Chanthick et al. 2008). This is probably a true allergic response as a good correlation between serology and IDT for the house dust mite allergens was found in a study from Japan (Masuda et al. 2000). In our study the mites, *Dermatophagoides farinae* and *D. pteronyssinus*, and house dust were grouped together for statistical analysis, but each one was tested separately by IDT (house dust was tested in the earlier period of the study only). This approach is more accurate and leads to fewer false negatives (Hillier et al. 2000).

Allergens from pollens of weeds and trees were important in this study as in the USA, but unlike both the USA and Europe, dog epithelium was of minimal importance here (Hill and DeBoer 2001).

In this study and in Greece, domesticated poultry feathers were among the least common allergens (Saridomichelakis et al. 1999). This may be more due to coincidence, because these feathers are less likely to be influenced by geographical location.

Positive reactions to allergens were not correlated with most of the parameters of signalment, lifestyle and distribution of lesions.

Only 20% of dogs in this study were positive to flea allergens. No statistical significance was found between positive reactions to fleas and dorsal distribution of skin lesions. These results suggest that allergic dogs may react to flea allergens even though they do not have FAD. In another study, however, the frequency of insect-positive reactions was similar in allergic and normal dogs (Willis et al. 1996).

In conclusion, a very early onset of clinical signs, especially in breeds that are predisposed to CAD, and dorsal distribution of skin lesions, should be borne in mind when considering a diagnosis of CAD.

REFERENCES

Bensignor E, Carlotti DN (2002): Sensitivity patterns to house dust mites and forage mites in atopic dogs: 150 cases. Veterinary Dermatology 13, 37–42.

Chanthick C, Anaman S, Buathet K (2008): The prevalence of positive intradermal allergy tests in 114 dogs with atopic dermatitis in the Bangkok metropolis, Thailand. Veterinary Immunology and Immunopathology 126, 256–262.

DeBoer DJ, Hillier A (2001): The ACVD task force on canine atopic dermatitis (XV): fundamental concepts in clinical diagnosis. Veterinary Immunology and Immunopathology 81, 271–276.

Favrot C, Steffan J, Seewald W, Picco F (2010): A prospective study on the clinical features of chronic canine atopic dermatitis and its diagnosis. Veterinary Dermatology 21, 23–31.

Fraser MA, McNeil PE, Girling SJ (2008): Prediction of future development of canine atopic dermatitis based on examination of clinical history. Journal of Small Animal Practice 49, 128–132.

Griffin CE, DeBoer DJ (2001): The ACVD task force on canine atopic dermatitis (XIV): clinical manifestations of canine atopic dermatitis. Veterinary Immunology and Immunopathology 81, 255–269.

Halliwell R (2006): Revised nomenclature for veterinary allergy. Veterinary Immunology and Immunopathology 114, 207–208.

Hill PB, DeBoer DJ (2001): The ACVD task force on canine atopic dermatitis (IV): environmental allergens Veterinary Immunology and Immunopathology 81, 169–186.

Hillier A, DeBoer DJ (2001): The ACVD task force on canine atopic dermatitis (XVII): intradermal testing. Veterinary Immunology and Immunopathology 81, 289–304.

Hillier A, Kwochka KW, Pinchbeck LR (2000): Reactivity to intradermal injection of extracts of Dermatophagoides farinae, Dermatophagoides pteronyssinus, house dust mite mix, and house dust in dogs suspected to have atopic dermatitis: 115 cases (1996–1998). Journal of the American Veterinary Medical Association 217, 536–540.

Jaeger K, Linek M, Power HT, Bettenay SV, Zabel S, Rosychuk RA, Mueller RS (2010): Breed and site predispositions of dogs with atopic dermatitis: a comparison of five locations in three continents. Veterinary Dermatology 21, 118–122.

Masuda K, Sakaguchi M, Fujiwara S, Kurata K, Yamashita K, Odagiri T, Nakao Y, Matsuki N, Ono K, Watari T, Hasegawa A, Tsujimoto H (2000): Positive reactions to common allergens in 42 atopic dogs in Japan. Veterinary Immunology and Immunopathology 73, 193–204.

Mueller RS, Bettenay SV, Tideman L (2000): Aero-allergens in canine atopic dermatitis in southeastern Australia based on 1000 intradermal skin tests. Australian Veterinary Journal 78, 392–399.

Muse R, Griffin CE, Rosenkrantz WS (1996): The prevalence of otic manifestation and otitis externa in atopic dogs. In: Proceedings of the Annual Meeting of the American Academy of Veterinary Dermatology and the American College of Veterinary Dermatology. April, Las Vegas, USA. 33 pp.

Nodtvedt A, Bergvall K, Emanuelson U, Egenvall A (2006): Canine atopic dermatitis: validation of recorded diagnosis against practice records in 335 insured Swedish dogs. Acta Veterinaria Scandinavica 48 (1), 8 Published online 2006 June 15. doi: 10.1186/1751-0147-48-8.

Nodtvedt A, Bergvall K, Sallander M, Egenvall A, Emanuelson U, Hedhammar A (2007): A case-control study of risk factors for canine atopic dermatitis among boxer, bullterrier and West Highland white terrier dogs in Sweden. Veterinary Dermatology 18, 309–315.

Picco F, Zini E, Nett C, Naegeli C, Bigler B, Rufenacht S, Roosje P, Gutzwiller ME, Wilhelm S, Pfister J, Meng E, Favrot C (2008): A prospective study on canine atopic dermatitis and food-induced allergic dermatitis in Switzerland. Veterinary Dermatology 19, 150–155.

Reedy LM, Miller WH, Willemse T (1997): Allergic Skin Diseases of Dogs and Cats. 2nd ed. WB Saunders, London, UK. 267 pp.

Rosser EJ Jr (2004): Causes of otitis externa. Veterinary Clinics of North America: Small Animal Practice 34, 459–468.

Saridomichelakis MN, Koutinas AF, Gioulekas D, Leontidis L (1999): Canine atopic dermatitis in Greece:

clinical observations and the prevalence of positive intradermal test reactions in 91 spontaneous cases. Veterinary Immunology Immunopathology 69, 61–73.

Schick RO, Fadok VA (1986) Responses of atopic dogs to regional allergens: 268 cases (1981–1984). Journal of the American Veterinary Medical Association 189, 1493–1496.

Scott, DW, Miller WH, Griffin CE (2001): Skin immune system and allergic skin disease. In: Miller and Kirk's Small Animal Dermatology. 6th ed. WB Saunders Co., Philadelphia, Pennsylvania. 543–666.

Shaw SC, Wood JL, Freeman J, Littlewood JD, Hannant D (2004): Estimation of heritability of atopic dermatitis in Labrador and Golden Retrievers. American Journal of Veterinary Research 65, 1014–1020.

Tarpataki N, Papa K, Reiczigel J, Vajdovich P, Vorosi K (2006): Prevalence and features of canine atopic dermatitis in Hungary. Acta Veterinaria Hungarica 54, 353–366.

Wilhem S, Kovalik M Favrot C (2011): Breed-associated phenotypes in canine atopic dermatitis. Veterinary Dermatology 22, 143–149.

Willemse T (1986): Atopic skin disease: a review and reconsideration of diagnostic criteria. Journal of Small Animal Practice 27, 771–778.

Willis EL, Kunkle GA, Esch RE, Grier TJ, Kubilis PS (1996): Intradermal reactivity to various insect and arachnid allergens among dogs from the southeastern United States. Journal of the American Veterinary Medical Association 209, 1431–1434.

Youn HY, Kang HS, Bhang DH, Kim MK, Hwang CY, Han HR (2002): Allergens causing atopic diseases in canine. Journal of Veterinary Science 3, 335–341.

Zur G, Ihrke PJ, White SD, Kass PH (2002): Canine atopic dermatitis: a retrospective study of 266 cases examined at the University of California, Davis, 1992–1998. Part I. Clinical features and allergy testing results. Veterinary Dermatology 13, 89–102.

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Corresponding Author:

Gila Zur, The Veterinary Teaching Hospital, Koret School of Veterinary Medicine, The Hebrew University of Jerusalem, PO Box 12, Rehovot 76100, Israel
Tel +972 3 9688547, E-mail: zurgila@agri.huji.ac.il