

Presence and density of domestic mites in the microenvironment of mite-sensitive dogs with atopic dermatitis

Rania Farmaki*, Manolis N. Saridomichelakis*, Leonidas Leontides†, Margarita G. Papazahariadou‡, Dimitrios Gioulekas§ and Alexander F. Koutinas¶

*Clinic of Medicine, Faculty of Veterinary Medicine, University of Thessaly, Karditsa, Greece

†Laboratory of Epidemiology, Biostatistics and Animal Health Economics, Faculty of Veterinary Medicine, University of Thessaly, Karditsa, Greece

‡Laboratory of Parasitology, Faculty of Veterinary Medicine, Aristotles University of Thessaloniki, Thessaloniki, Greece

§Pulmonary Clinic, Faculty of Medicine, Aristotles University of Thessaloniki, Thessaloniki, Greece

¶Companion Animal Clinic, Faculty of Veterinary Medicine, Aristotles University of Thessaloniki, Thessaloniki, Greece

Correspondence: Rania Farmaki, Clinic of Medicine, Faculty of Veterinary Medicine, University of Thessaly, Triklon 224, GR 43100, Karditsa, Greece. E-mail: rfarmaki@gmail.com

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Conflict of Interest

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Abstract

This study was designed to investigate the presence and density of domestic mites (DMs) in households with atopic dogs sensitive to these mites (group A; $n = 20$), in households with clinically healthy, non-atopic dogs (group B; $n = 20$) and in households without pets (group C; $n = 25$). Dust samples were vacuum-collected from the owner mattress (all groups) and dog sleeping area (groups A and B) or living room couch (group C) on four consecutive occasions, reflecting the four seasons of the year. DMs were found, at least once, in 19 of 20 (95%) group A, 13 of 20 (65%) group B and 21 of 25 (84%) group C households. DM numbers per gram of dust were 0–159 (median, 8.8), 0–302 (median, 3) and 0–1473 (median, 6.9) for group A, B and C, respectively. *Dermatophagoides farinae* predominated in all groups, since it was identified in 60% of group A, 40% of group B and 64% of group C households. *Dermatophagoides pteronyssinus* was found in 45%, 35% and 48% of households, in group A, B and C, respectively. No differences were found between households with (groups A and B) or without dogs (group C). When considering both sampling sites together, frequency of DM recovery was higher in group A than in group B ($P = 0.044$). Also, both mite frequency ($P = 0.011$) and density ($P = 0.015$) in dog sleeping area were higher in group A than in group B. In conclusion,

presence and density of DMs is higher in the microenvironment of mite-sensitive dogs with atopic dermatitis than in that of clinically healthy nonatopic dogs.

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Introduction

Canine atopic dermatitis (CAD) has been recently defined as a genetically predisposed inflammatory and pruritic allergic skin disease, with characteristic clinical features, associated with IgE antibodies most commonly directed against environmental allergens.¹ The increased frequency of CAD during the last decades makes it the most common allergic dermatitis of the dog.^{2–5} Despite numerous publications on the aetiopathogenesis of this disease, there is still insufficient information regarding its association with the various environmental allergens.

Domestic mites (DMs), including house dust (e.g. *Dermatophagoides farinae*, *Dermatophagoides pteronyssinus*) and storage mites (e.g. *Acarus siro*, *Tyrophagus putrescentiae*, *Lepidoglyphus destructor*), seem to be the most important sources of environmental allergens, such as *Der f* 15 and *Der f* 18, that are responsible for the sensitization of atopic dogs.^{2,3,6–10} Nevertheless, the density of DMs differs, mainly due to the influence of local climatic conditions, such as relative humidity and temperature.^{11–13} Their common presence in modern households, witnessed decades ago, has been attributed to the almost ideal indoor microenvironment.¹⁴ Detection of their presence and quantification in dust samples can be accomplished, either directly (recovery of mite bodies) or indirectly, by measuring the concentration of their allergens by enzyme-linked immunosorbent assay (ELISA) or that of guanine, their major metabolic byproduct.^{15–17} Based on previous studies, DMs, their allergens and/or guanine may be recovered from samples obtained from the skin, hair coat and the microenvironment of clinically healthy and atopic dogs.^{17–22} However, to the best of our knowledge, the presence of DMs themselves in the microenvironment of dogs with atopic dermatitis with documented mite sensitivity has not been reported.

In atopic humans, a relationship between exposure to DM allergens and sensitization or allergic clinical manifestations has been proposed; presence of ≥ 100 and of ≥ 500 DMs/g of dust increases the possibility of sensitization and asthma induction, respectively.^{14,23–27} Whether the same is true in CAD is still unknown, although in one

study the concentrations of DM allergens did not differ between households with atopic and healthy dogs.²⁰

The objective of this study was to investigate the presence and density of DM in households with DM-sensitive dogs diagnosed with CAD and to compare these findings with households with clinically healthy dogs and households with no dogs or other terrestrial pet animals.

Materials and methods

Selection of households and dogs – study design

Dust samples were collected from a total of 65 households, including 20 households with mite-sensitive dogs with CAD (group A), 20 with clinically healthy dogs (group B) and 25 without pets (group C).

Group A ($n = 20$) comprised six male (one castrated) and 14 female (three neutered), DM-sensitive atopic dogs. They belonged to ten different breeds (13 of 20) or were crossbreds (seven of 20), and had an age range of 1–10 years (median = 4.5 years). Canine atopic dermatitis was diagnosed by the Dermatology Service of the Companion Animal Clinic (Faculty of Veterinary Medicine, Aristotle University of Thessaloniki, Greece) on the basis of compatible history and clinical signs, positive intradermal testing (IDT) and ELISA serology for environmental allergen-specific IgE, fulfilment of at least three of the major and three of the minor diagnostic criteria proposed by Willemse,²⁸ exclusion of other pruritic skin diseases (e.g. sarcopic mange, otodectic mange, flea allergic dermatitis, adverse food reactions) and the persistence of pruritus after the elimination of complicating conditions, such as staphylococcal pyoderma and *Malassezia* dermatitis.^{29,30} Skin scrapings, ear canal parasitological examination and response to treatment trials were used to rule out ectoparasites. The possibility of adverse food reaction was eliminated through a 6-week trial with novel-protein and home-cooked (eight of 20) or commercial diets with hydrolysed proteins (12 of 20). Also, concurrent staphylococcal (11 of 20) and/or *Malassezia* (five of 20) dermatitides were eliminated with oral antibiotics and ketoconazole, respectively. In order to confirm that these dogs were sensitive to DMs, the following inclusion criteria were used: (i) presence of perennial pruritus; (ii) exclusive indoor lifestyle; (iii) positive IDT to at least one of the five DM species tested (*D. farinae* and *D. pteronyssinus* from Greer Laboratories Inc., Lenoir, NC, USA at 1/5000 w/v concentration; *A. siro*, *T. putrescentiae* and *L. destructor* from Artu Biologicals NV, Lelystad, The Netherlands at 100 Noon Units/mL); (iv) positive serology (ALLERCEPT®, Heska Laboratories, Fribourg, Switzerland) to at least one of these five DMs; and (v) no historical evidence of previous parasitic mite infestations (e.g. sarcopic mange, otodectic mange, cheyletiellosis) that might have caused false-positive reactions.^{31–33} Finally, group A dogs had to live for at least 1 year in their present household, all located in the greater metropolitan area of Thessaloniki. In particular 16 of 20 (80%) of these dogs were living in the same household when the clinical signs of CAD first appeared, notably, from 6 months to 7 years (median = 2 years) before their admission.

Group B ($n = 20$) included nine intact male and 11 female (six neutered) clinically healthy dogs. These animals belonged to six different breeds (seven of 20) or were crossbreds and had an age range of 7 months to 16.5 years (median = 5 years). Based on historical data and physical examination findings, all 20 dogs were both systemically and dermatologically healthy, enjoyed an exclusive indoor lifestyle and had resided in their present household (located in the same area as that of group A dogs) for at least 1 year before commencement of the study. To reduce the potential of subclinical sensitization to DMs, group B dogs were all IDT negative to all five DM species.

Households without pets (group C; $n = 25$) were also located in the greater metropolitan area of Thessaloniki belonging to relatives or friends of the personnel of our Clinic and to veterinary students.

Study protocol and methodology had been approved by the Ethical Committee of the Faculty of Veterinary Medicine, Aristotle University of Thessaloniki. Also, written informed owner's consent was obtained before enrolment of the dogs into the study.

Collection of dust samples

For each household, dust samples were collected from two sites, the owner's mattress (first sampling site) and the dog's sleeping area (i.e. dog bed or couch), for groups A and B, or living room couch for group C (second sampling site). For groups A and B, the second sampling site was a dog bed (ten of 20 of group A and eight of 20 of group B households) or the living room couch (eight of 20 of group A and ten of 20 of group B households). In the remaining cases (two of 20 for both group A and group B), dogs slept on their owner's bed. Consequently, only one site was sampled from these four households. Dust samples were collected four times, corresponding to the middle of each season of the year (January, April, July and October), with a 700 W vacuum cleaner (Hobby, beetle). For each collection site, 1 m² of area was vacuumed for 2 min;³⁴ samples were collected in separate paper bags with pores <40 µm, transferred into plastic containers, sealed and kept refrigerated (4 °C) until analysed.²³ All parts of the vacuum cleaner were thoroughly cleaned with warm water after each use. The household and sampling site characteristics and cleaning practices are summarized on Table 1. The residents were instructed to avoid cleaning the sampling sites for at least 7 days before each collection and avoid the use of environmental acaricides or insecticides for as long as the study was in progress. Regular flea control measures for group A and B dogs were not changed during the study.

Mite and guanine detection technique

Guanine concentrations of dust samples were analysed, using a commercial test (Acarex® test; Lifestyle Vertiebsgesellschaft mbH, Wahlstedt, Germany), within 1 month after the collection. According to the manufacturer's instructions, results were expressed as 0 (negative), +1 (mild), +2 (moderate) or +3 (heavy guanine content). Subsequently, the dust samples were mechanically sieved (Laboratory Test Sieve®; AS200 Basic, Retsch GmbH & Co. KG, Haan, Germany) to remove large particles, such as hair, wood splints and small stones, and weighed (Kern 770; Kern & Sohn GmbH, Albstadt, Germany). DM density was counted after applying floatation technique³⁵ and expressed as number of mites per gram of dust. Dust mite species were identified to species level and when this was not possible only to genus or family level, using light microscopy.^{15,36–38} Unidentified mites included those that did not belong to DM species and were not included in data analysis.

Statistical analysis

The homogeneity of group A and B dogs regarding their sex (male or female) and breed (purebreds or crossbreds) distribution was examined by Pearson's chi-squared test, whereas Mann–Whitney *U*-test was used to compare the age of these dogs. Household and sampling site characteristics plus cleaning practices were compared between the three groups with Pearson's chi-squared test (qualitative variables) or Kruskal–Wallis ANOVA (quantitative variables). When significant differences were found, multiple pairwise comparisons were done, and significance was determined after Bonferroni's correction.³⁹

Frequency of DM recovery, detectable guanine concentrations (Pearson's chi-squared test) and DM numbers per gram of dust (Mann–Whitney *U*-test) were compared between groups A and B, as well as between households with (groups A and B combined) and without dogs (group C), for three different sets of data: (i) all eight samples obtained from each household; (ii) the four samples obtained from each sampling site; and (iii) the two samples obtained for each season of the year. For the same data sets, McNemar's test for symmetry was used to compare the sensitivity of direct DM recovery and guanine detection technique. The correlation between the quantitative results of these two methods was explored by the Spearman rank correlation coefficient, for each dust sample separately.³⁹

The significance of seasonal fluctuations in DM density, when all three groups were combined, was examined by Quade's test for: (i) both samples obtained from each household; and (ii) samples obtained from each collection site separately. When the result was significant, comparisons of each possible pair of seasons were done with Wilcoxon signed rank test, and significance was determined after Bonferroni's correction.³⁹

Table 1. Household and dust sampling site characteristics and cleaning practices of 20 households with mite-sensitive atopic dogs (group A), 20 households with clinically healthy, nonatopic dogs (group B) and 25 households without pets (group C)

	Group A (n = 20)	Group B (n = 20)	Group C (n = 25)
Household characteristics and cleaning practices			
Altitude [m; range (median)]	11–361 (53.5)	28–325 (56.5)	11–331 (36)
Type [frequency (%)]			
Apartment	18/20 (90)	16/20 (80)	23/25 (92)
Free standing	2/20 (10)	4/20 (20)	2/25 (8)
Age [years; range (median)]	1–45 (16.5)	7–42 (21)	10–32 (20)
Floor [range (median)]	0–6 (2)	0–5 (3)	0–6 (2)
Central heating [frequency (%)]	17/20 (85)	18/20 (90)	21/25 (84)
Air conditioning [frequency (%)]	8/20 (40)	11/20 (55)	12/25 (48)
Number of occupants [range (median)]	1–4 (2.5)	1–5 (3)	1–5 (3)
Indoor smoking [frequency (%)]	14/20 (70)	14/20 (70)	12/25 (48)
Number of dogs [range (median)]	1–2 (1)	1–2 (1)	0
Sweeping method [frequency (%)]			
Vacuum cleaner	18/20 (90)	19/20 (95)	24/25 (96)
HEPA vacuum cleaner	2/20 (10)	0	0
Broom	0	1/20 (5)	1/25 (4)
Sweeping frequency* [range (median)]	1–5 (3.5)	1–5 (3)	2–6 (4)
Dusting frequency* [range (median)]	1–6 (3)	1–5 (4)	1–6 (3)
Mopping frequency* [range (median)]	1–5 (3) ^a	1–5 (3) ^a	2–6 (4) ^b
Window opening frequency* [range (median)]	1–1 (1)	1–1 (1)	1–1 (1)
First sampling site (owner mattress, bedroom) characteristics and cleaning practices			
Mattress age [years; range (median)]	1–20 (8.25)	0.5–40 (8)	1–20 (7.5)
Mattress rotation [frequency (%)]	9/20 (45)	7/20 (35)	6/25 (24)
Feather beddings [frequency (%)]	10/20 (50) ^a	2/20 (10) ^b	4/25 (16) ^b
Bedding change frequency* [range (median)]	2–5 (4)	3–5 (4)	4–6 (4)
Bedroom type of floor [frequency (%)]			
Wood	15/20 (75)	15/20 (75)	22/25 (88)
Tile, marble	5/20 (25)	5/20 (25)	3/25 (12)
Bedroom floor age [years; range (median)]	2–45 (15)	8–30 (24)	3–32 (18)
Carpets in bedroom [frequency (%)]	7/14 (50)	16/20 (80)	21/25 (84)
Second sampling site (dog sleeping area or living room couch) characteristics and cleaning practices			
Mattress/couch age [years; range (median)]	0.8–20 (3.5)	0.4–40 (7.5)	1–27 (10)
Mattress/couch cases [frequency (%)]	6/18 (33.3) ^{a,b}	5/18 (27.8) ^a	17/25 (68) ^b
Room floor [frequency (%)]			
Wood	5/18 (27.8)	10/18 (55.6)	8/25 (32)
Tile, marble	13/18 (72.2)	8/18 (44.4)	17/25 (68)
Room floor age [years; range (median)]	2–45 (25)	20–30 (24)	10–30 (24.5)
Carpets in the room [frequency (%)]	8/18 (44.4) ^a	11/18 (61.1) ^{a,b}	21/25 (84) ^b

^{a,b}Values in the same row with different superscripts differ significantly ($P < 0.05$).

HEPA, high efficiency particulate arresting.

*Frequency of cleaning practices: 1 = daily, 2 = twice per week, 3 = once or twice per week, 4 = once weekly, 5 = every 2 weeks and 6 = monthly.

Mattresses or couch cases are the coverings that were used on couches and dog's sleeping area.

Statistical analyses were performed in SPSS 13.3 for Windows (SPSS Inc., Chicago, IL, USA) or STATXACT, version 7 (Cytel Inc., Cambridge, MA, USA), and P values of <0.05 were considered significant.

Results

Homogeneity of dog groups, household and sampling site characteristics and cleaning practices

There were no differences between group A and B dogs regarding their sex, breed and age distributions. Mopping frequency was lower in group C compared with groups A ($P = 0.002$ for the household as a whole, $P = 0.005$ for the first sampling site, $P = 0.008$ for the second sampling site) and B ($P = 0.007$ for the household, $P = 0.003$ for the first sampling site, $P = 0.002$ for the second sampling site). Feather mattresses in bedrooms were more frequent in group A compared with B ($P = 0.006$) and C ($P = 0.014$). Considering the second sampling site,

coverings were more frequent in group C couches compared with group B dog sleeping area ($P = 0.009$); carpets were more frequent in group B compared with group A ($P = 0.006$), and sweeping frequency was higher in group B than in group C ($P = 0.008$; Table 1).

Presence and density of DMs in dust samples

When all eight dust samples from each household were combined, at least one DM species was recovered from 95% (19 of 20) group A, 65% (13 of 20) group B and 84% (21 of 25) group C households. DM numbers per gram of dust ranged from 0 to 159 (median, 8.8), from 0 to 302 (median, 3), and from 0 to 1473 (median, 6.9) in group A, B and C, respectively (Table 2). *Dermatophagoides farinae* predominated in all groups, since it was identified in 60% of group A, 40% of group B and 64% of group C households. *Dermatophagoides pteronyssinus* was found in 45%, 35% and 48% of group A, B and C households,

Table 2. Presence [frequency (%)] and density per gram of dust [range (median)] of domestic mites in dust samples collected from owner's mattress (first sampling site) and dog sleeping area or living room couch (second sampling site) of 20 households with mite-sensitive atopic dogs (group A), 20 households with clinically healthy, nonatopic dogs (group B) and 25 households without pets (group C)

Site	Group A (n = 20)		Group B (n = 20)		Group C (n = 25)	
	Frequency	Density	Frequency	Density	Frequency	Density
All four seasons dust collection						
Both	19/20 (95) ^a	0–159 (8.8)	13/20 (65) ^b	0–302.6 (3)	21/25 (84)	0–1473.1 (6.9)
First	15/20 (75)	0–300.9 (7.4)	13/20 (65)	0–284.4 (2.8)	20/25 (80)	0–6688 (4.8)
Second	16/18 (89) ^a	0–180.6 (8) ^c	9/18 (50) ^b	0–116.8 (1.1) ^d	17/25 (68)	0–19,245.9 (6.6)
Spring dust collection						
Both	11/20 (55)	0–64.3 (0.7)	7/20 (35)	0–40.6 (0)	13/25 (52)	0–234.1 (0.8)
First	6/20 (30)	0–231.8 (0)	6/20 (30)	0–118.1 (0)	9/25 (36)	0–401.9 (0)
Second	10/18 (55.6)	0–35.8 (1.1)	4/18 (22.2)	0–47.5 (0)	10/25 (40)	0–216.5 (0)
Summer dust collection						
Both	13/20 (65)	0–41.6 (1.9)	9/18 (50)	0–13.6 (0.5)	14/25 (56)	0–411.2 (2.7)
First	8/20 (40)	0–27 (0)	5/18 (27.8)	0–45 (0)	11/25 (44)	0–957.5 (0)
Second	11/18 (61.1)	0.7–5.9 (2.7)	5/17 (29.4)	0–87.7 (0)	11/25 (44)	0–18,571.4 (0)
Autumn dust collection						
Both	11/20 (55)	0–68.5 (0.9)	10/20 (50)	0–300 (0.3)	14/25 (56)	0–760 (2.1)
First	8/20 (40)	0–60.6 (0)	8/20 (40)	0–281.7 (0)	11/25 (44)	0–5144.2 (0)
Second	8/18 (44.4)	0–101.2 (0)	6/18 (33.3)	0–25 (0)	10/25 (40)	0–1525.4 (0)
Winter dust collection						
Both	10/20 (50)	0–38.2 (0.2)	6/20 (30)	0–41.9 (0)	13/25 (52)	0–200 (0.6)
First	9/20 (45)	0–55.4 (0)	5/20 (25)	0–59.3 (0)	8/25 (32)	0–184.4 (0)
Second	4/18 (22.2)	0–33.3 (0)	2/18 (11.1)	0–40 (0)	10/25 (40)	0–346.2 (0)

^{a,b,c,d} Different superscripts in the same row indicate significant differences ($P < 0.05$).

respectively. Overall, *Dermatophagoides* spp. were found in 45% group A, 20% group B and 24% group C households. *Acarus siro* was found in only 10% of group A, *T. putrescentiae* in only 5% of group B, and *L. destructor* in 5% of both group A and B households. Furthermore, Acaridae were found in 20% of group A and 4% of group C and *Glyciphagidae* in 5% and 4% of group B and C households, respectively. Unidentified mites predominated in group A (80%) in contrast to group B (35%) and C households (36%). Frequency of recovery and DM density did not differ between households with (groups A and B) and without dogs (group C), but at least one DM was more frequently found in group A than in group B household dust samples ($P = 0.044$).

Presence and density of DMs in each sampling site and for each season of the year are presented on Table 2. The only significant difference between groups was the higher recovery rate ($P = 0.011$) and the increased density ($P = 0.015$) of DMs in mite-sensitive atopic dog sleeping areas (group A) compared with those of healthy dogs (group B). Seasonal fluctuations in DM density, when data from all three groups and both sampling sites were combined, were found to be significant; in particular, DM numbers were lower in the winter than in summer ($P = 0.002$) or autumn samples ($P = 0.003$).

Guanine concentration in dust samples

Guanine was detected in at least one of the eight dust samples obtained from each of seven of 20 (35%) group A, three of 20 (15%) group B and eight of 25 (32%) group C households (Table 3). Results ranged from 0 (negative) to +3 (heavy guanine content) even though the median remained at 0. Results were not different between households with (groups A and B) and without dogs

(group C). In contrast, detectable guanine concentrations were more frequently noticed in dust samples from households with mite-sensitive atopic dogs (group A) than from households with dogs without mite sensitivity (group B) during the spring ($P = 0.044$) or summer months ($P = 0.021$; Table 3).

Comparison between direct and guanine detection in DMs

Diagnostic sensitivity of the direct DM detection was higher ($P < 0.001$) than that of their guanine byproduct in all possible comparisons made (for all eight samples obtained from each household, the four samples obtained from each sampling site, and the two samples obtained on each season of the year). Furthermore, there was a positive correlation ($P \leq 0.003$) between DM density and the quantitative results of the guanine detection method in samples obtained from either sampling site during each season of the year.

Discussion

The inclusion criteria applied to group A dogs not only confirmed the diagnosis of CAD, but also their natural sensitization to DMs (positive IDT and serology, perennial pruritus, indoor lifestyle, no historical evidence of parasitic mite infestations). The recorded DM density was hypothesized to represent dog exposure to these allergens, hence contributing to CAD-specific clinical signs, at least for the past year. Also, for some of these dogs (16 of 20) that were living in the sampled household when clinical signs of CAD first appeared, DM load could be indicative of exposure to their allergens during the sensitization period, although DM density tends to increase the older

Table 3. Detectable guanine concentrations [frequency (%)] in dust samples collected from owner's mattress (first sampling site) and dog sleeping area or living room couch (second sampling site) of 20 households with mite-sensitive atopic dogs (group A), 20 households with clinically healthy, nonatopic dogs (group B) and 25 households without pets (group C)

Site	Group A (n = 20)	Group B (n = 20)	Group C (n = 25)
All four seasons dust collection			
Both	7/20 (35)	3/20 (15)	8/25 (32)
First	4/20 (20)	3/20 (15)	6/25 (24)
Second	6/18 (33.3)	1/18 (5.6)	7/25 (28)
Spring dust collection			
Both	7/20 (35) ^a	1/20 (5) ^b	4/25 (16)
First	4/20 (20)	1/20 (5)	4/25 (16)
Second	4/18 (22.2)	0/18	3/25 (12)
Summer dust collection			
Both	6/20 (30) ^a	0/18 ^b	7/25 (28)
First	4/20 (20)	0/18	5/25 (20)
Second	4/18 (22.2)	0/17	5/25 (20)
Autumn dust collection			
Both	6/20 (30)	3/20 (15)	6/25 (24)
First	4/20 (20)	3/20 (15)	5/25 (20)
Second	4/18 (22.2)	1/18 (5.6)	4/25 (16)
Winter dust collection			
Both	4/20 (20)	0/20	6/25 (24)
First	4/20 (20)	0/20	4/25 (16)
Second	2/18 (11.1)	0/18	4/25 (16)

^{a,b}Different superscripts in the same row indicate significant differences ($P < 0.05$).

the home.³⁴ Control dogs (group B), living in similar conditions, had to be IDT negative to DMs, in an attempt to rule-out the potential of their subclinical sensitization. Finally, households without dogs (group C) were included in the study to investigate the impact of dog presence on DM density.

Dust samples were collected from the owner's mattress, thought to be the main DM source in a house, from the living room couch (group C), also a heavily infested site,^{12,15,23,34,40} and from the dog's sleeping area (groups A and B), which may constitute an important source for allergen exposure. The longitudinal study design (four consecutive samplings, one for each season of the year) was decided in an attempt to overcome the relatively low sensitivity of direct DM detection,^{41,42} and to evaluate the seasonal fluctuations, if any, to DM density.

Few differences could be found among the animal groups regarding household and sampling site characteristics as well as cleaning practices applied by the owners. Some of them, like the higher cleaning level in group A and/or B compared to group C households, can be easily explained by the mere presence of dogs and dog hair, whereas the more common use of feather mattresses in the bedroom of owners of group A dogs could be considered incidental. Although household characteristics and cleaning practices may influence DM density,^{17,20,24,34} the differences noticed in the present study were habitual and presumably did not influence the validity of our results.

Dust mites were recovered from more than half (65%) of the households keeping clinically healthy dogs and in

50% of their sleeping areas. In previous studies in which similar techniques have been employed,^{17,19,43} the relevant figures were lower, ranging from 12.5% to 60% for households^{17,43} and from 12.1% to 26.5% for the dog's sleeping area.^{17,19} Apart from the impact associated with the geographical area, multiple sampling may have increased the frequency of DM detection. It should be mentioned that detectable DM allergen concentrations have been recorded at a higher frequency (up to 85% for *Der f 1*) in dog beds,^{17,19} due to the increased sensitivity of allergen detection compared with the direct technique of DM retrieval. Putting these data together, we may conclude that the dog sleeping area is a rich source of DMs, as is also the case with the human mattress.^{11,12,15,27,34,40}

At least one DM was found in almost all households (95%) and sleeping areas (89%) of mite-sensitive dogs with AD. Regarding the relatively low sensitivity of the technique applied, it is assumed that DMs are almost always present in the microenvironment of these patients and that their sleeping area is a major allergen source. Furthermore, the higher frequency of DM recovery from the household and, more importantly, the higher recovery rate and density of DMs in the sleeping area of group A dogs compared with group B might lead one to believe that this provides indirect evidence that sensitization and clinical expression of DM-associated CAD may be associated with their increased load in the microenvironment of dogs. This assumption should be viewed with skepticism for the following reasons: (i) a cause-and-effect relationship can never be established with observational studies; (ii) genetic predisposition, not evaluated in this study, plays a major role in sensitization to environmental allergens and clinical expression of CAD;⁴⁴ (iii) the DM density recorded may not reflect the situation during the sensitization period of group A dogs; and (iv) the clinical picture of CAD was not scored to be correlated with DM loads.

Another interesting finding was the relatively low median DM density per gram of dust in group A households (8.8), owner mattress (7.4) and dog sleeping area (8). In human eczema, presence of ≥ 100 DMs/g of dust increases the possibility of sensitization, while in asthma ≥ 500 DMs/g of dust is needed for the same purpose.^{14,23–27} Also, DM density in households inhabited by asthmatic patients has been higher than that recorded in this study. In particular, the median number of DMs has been estimated as 32/g of dust in Sweden,²⁷ and more than 100 DMs/g of dust in 83.3% of asthmatic patient households in the USA.²³ Interestingly, the generally accepted cut-off concentration of DM allergens which is needed for the clinical expression of allergic diseases in humans (2 μ g/g of dust)^{14,24,25,27} was found in only 6–42% of dust samples collected from households with atopic dogs in Austria and the UK.^{20,45} Although regional differences may explain some of these findings, we hypothesize that lower DM density is needed for the sensitization and clinical expression of CAD than for human asthma. While allergen inhalation plays a pivotal role in allergic human asthma,¹⁴ the same is true for percutaneous exposure in CAD,^{46,47} which may increase the chances for DM sensitization, even at relatively low loads.

Domestic mite retrieval frequency and density were not different between households with and without dogs. This is still a controversial issue for households with dogs, since some studies have shown increased DM numbers and/or allergens,⁴⁸ while in others there has been no difference³⁴ or even lower DM allergen concentrations.²⁰

Domestic mite density is heavily influenced by environmental relative humidity and temperature.^{11–13} In the interior of modern households, temperature remains relatively stable throughout the year, whereas more frequent window opening during the warm season of the year and central heating in the winter may increase and decrease, respectively, the relative humidity,³⁴ thus explaining the lower DM load in the samples collected in the winter. These fluctuations may partly explain the seasonality of clinical signs in some mite-sensitive atopic dogs,⁴⁹ although these results do not apply to all geographical areas, and DM allergens do not necessarily follow the number of DMs because they are still present in the microenvironment of dogs long after the death of mites.^{14,50}

Regardless of the positive correlation found between the quantitative results of direct DM collection and the guanine detection technique, the latter is considered less sensitive since, in a previous study using the same technique the results were negative in 40% of the households where mite-sensitive atopic dogs were living.²² According to the manufacturer, Acarex[®] test turns positive at guanine concentrations of 0.3–0.8 mg/g of dust, whereas independent studies have shown a higher detection limit at 2 mg/g.¹⁶ The sensitivity of this test is perhaps enough to detect the relatively high DM loads commonly associated with human atopy, but it is certainly of low diagnostic yield when applied in the analysis of dust samples collected from the microenvironment of atopic dogs.

Domestic mites are often present in the microenvironment of mite-sensitive dogs with CAD. The frequency of isolation and density of DMs is higher in the sleeping area of affected dogs when compared with nonatopic dogs. Further studies are needed to explore the association between DM load and CAD in terms of the number of DMs required for the sensitization of genetically predisposed dogs and its influence on the severity of clinical manifestations of the disease.

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Résumé L'objectif de cette étude est de déterminer la présence et la densité des acariens domestiques dans les habitats de chiens atopiques sensibilisés à ces acariens (groupe A; $n = 20$), de chiens sains non-atopiques (groupe B; $n = 20$), et dans des maisons sans animal domestique (groupe C; $n = 25$). Des échantillons de poussière ont été prélevés par aspiration sur les matelas des propriétaires (tous les groupes), sur les aires de couchage des chiens (groupes A et B) et sur le canapé (groupe C), quatre fois dans l'année, chaque prélèvement correspondant à une des quatre saisons. Les acariens domestiques ont été trouvés, au moins une fois dans 19 habitats sur 20 (95%) du groupe A, 13 sur 20 (65%) du groupe B et 21 sur 25 (84%) du groupe C. Le nombre d'acarien par gramme de poussière était de 0–159 (médiane: 8.79), 0–302 (médiane: 3) et 0–1.473 (médiane: 6.87) respectivement pour les groupes A, B et C. Dans tous les groupes, *D. farinae* prédominait et a été identifié dans 60% des habitations du groupe A, 40% du groupe B et 64% du groupe C. *Dermatophagoides pteronyssinus* a été retrouvé respectivement dans 45%, 35% et 48% des groupes A, B et C. Aucune différence n'a été mise en évidence entre les groupes avec chiens (A et B) et sans (groupe C). En considérant les deux sites de prélèvement ensemble, la fréquence de récupération des acariens domestiques était plus élevée dans le groupe A que dans le groupe B ($P = 0.044$). En outre, la fréquence des acariens ($P = 0.011$) ainsi que leur densité ($P = 0.015$) sur les aires de couchage étaient plus élevées dans le groupe A que dans le groupe B. En conclusion, la présence et la densité des acariens domestiques sont plus élevées dans l'environnement des chiens atopiques sensibilisés aux acariens que dans celui des chiens non-atopiques sains.

Resumen Este estudio se diseñó para investigar la presencia y densidad de ácaros domésticos en los hogares con perros atópicos sensibilizados a esos ácaros (grupo A; $n = 20$), perros sanos clínicamente no atópicos (grupo B; $n = 20$), y en hogares sin animales domésticos (grupo C; $n = 25$). Las muestras de polvo fueron recogidas con aspiradora de los colchones (todos los grupos) y de áreas donde dormían los perros (grupos A–B) o del sofá de la sala de estar (grupo C), en cuatro ocasiones consecutivas, reflejando las cuatro estaciones del año. Ácaros domésticos se encontraron al menos una vez en 19 de 20 hogares (95%) del grupo A, 13 de 20 del grupo B (65%) y 21 de 25 del grupo C (84%). El número de ácaros domésticos por gramo de polvo fue de 0–159 (mediana: 8,79); 0–302 (mediana: 3) y 0–1.473 (mediana: 6,87) respectivamente para los grupos A, B y C. En todos los grupos, *D. farinae* predominó y fue identificado en el 60% de las viviendas del grupo A, el 40% del grupo B y el 64% del grupo C. *Dermatophagoides pteronyssinus* fue encontrado respectivamente en el 45%, 35% y el 48% de los grupos A, B y C. No se encontró diferencia entre los grupos con perros (A y B) y sin (grupo C). Considerando los dos sitios de muestreo juntos, la frecuencia de recuperación de los ácaros domésticos era más alta en el grupo A que en el grupo B ($P = 0,044$). Además, la frecuencia de los ácaros ($P = 0,011$) así como su densidad ($P = 0,015$) en las áreas de sueño eran más altas en el grupo A que en el grupo B. En conclusión, la presencia y la densidad de los ácaros domésticos son más altas en el entorno de los perros atópicos sensibilizados a los ácaros que en el de los perros no atópicos sanos.

6,87) para los grupos A, B y C, respectivamente. *Dermatophagoides farinae* fue el ácaro predominante en todos los grupos, ya que fue identificado en 60% de los casos del grupo A, 40% del grupo B y 64% del grupo C. *Dermatophagoides pteronyssinus* fue encontrado en 45%, 35% y 48% en los hogares de los grupos A, B y C, respectivamente. No se observaron diferencias entre los hogares con (grupos A y B) o sin (grupo C) perros. Cuando se consideraron juntas ambas zonas de muestreo, la frecuencia de la recuperación de ácaros fue mayor en el grupo A que en el grupo B ($P = 0,044$). También, tanto la frecuencia ($P = 0,011$) como la densidad ($P = 0,015$) en las zonas donde dormían los perros fueron mayores en el grupo A que en el grupo B. En conclusión, la presencia y densidad de los ácaros domésticos es mayor en un ambiente de perros sensibles al ácaro con dermatitis atópica que en aquellos con perros clínicamente sanos.

Zusammenfassung Diese Studie wurde entworfen, um das Vorkommen und die Dichte von Haushaltsmilben in Haushalten mit atopischen Hunden, die auf diese Milben empfindlich waren (Gruppe A; $n = 20$), mit klinisch normalen nicht-atopischen Hunden (Gruppe B; $n = 20$) und in Haushalten ohne Haustiere (Gruppe C; $n = 25$) zu untersuchen. Staubproben wurden mittels Staubsauger von Matratzen der BesitzerInnen (bei allen Gruppen) und von den Hundeschlafplätzen (Gruppe A–B) oder von der Wohnzimmercouch (Gruppe C) an vier aufeinander folgenden Zeitpunkten, welche die vier Jahreszeiten reflektierten, gesammelt. Haushaltsmilben wurden mindestens einmal bei 19 von 20 (95%) der Haushalte in Gruppe A, bei 13 von 20 (65%) in Gruppe B und 21 von 25 (84%) in Gruppe C gefunden. Die Anzahl der Haushaltsmilben pro Gramm Staub betrug 0–159 (Median: 8.79), 0–302 (Median: 3) bzw. 0–1.473 (Median: 6.87) in den Gruppen A, B bzw. C. *Dermatophagoides farinae* war in allen Gruppen vorherrschend, da sie in 60% der Haushalte von Gruppe A, in 40% der Haushalte von Gruppe B und in 64% der Haushalte von Gruppe C identifiziert wurde. *Dermatophagoides pteronyssinus* wurde in 45% der Gruppe A, in 35% der Gruppe B und in 48% der Gruppe C gefunden. Es wurden zwischen den Haushalten mit (Gruppen A und B) und ohne Hunde (Gruppe C) keine Unterschiede gefunden. Wenn beide Probeentnahmestellen gemeinsam betrachtet wurden, war die Frequenz mit der Haushaltsmilben gefunden wurden in Gruppe A größer als in Gruppe B ($P = 0.044$). Ebenso waren sowohl die Frequenz, mit der Milben gefunden wurden ($P = 0.011$) als auch die Dichte der Milben ($P = 0.015$) auf den Hundeschlafplätzen in Gruppe A höher als in Gruppe B. Zusammenfassend kann man sagen, dass das Vorkommen und die Dichte von Haushaltsmilben in der Mikroumgebung von milben-sensiblen Hunden mit atopischer Dermatitis höher sind als in jener von klinisch gesunden nicht-atopischen Hunden.

要約 本研究はダニ過敏症のアトピー犬家庭 (グループ A; $n = 20$)、臨床的に健康な非アトピー犬家庭 (グループ B; $n = 20$) とペットのいない家庭 (グループ C; $n = 25$) でのダニの存在と家庭内のダニ濃度の評価のために設計された。埃のサンプルは家主のマットレス (すべてのグループ) とイヌの睡眠スペース (グループ A と B) またはリビングルームのソファ (グループ C) から 4 日連続で、1 年の 4 つの季節を反映するように掃除機で集められた。ハウスダストマイトはグループ A で 20 例中 19 例 (95%)、グループ B で 20 例中 13 例 (65%) で、グループ C で 25 例中 21 例で少なくとも 1 回発見された。埃 1g あたりの家庭内ハウスダストマイト数はグループ A、B、C の順に 0–159 (中央値: 8.79)、0–302 (中央値: 3)、0–1473 (中央値: 6.87) であった。コナヒョウダニ (*D. farinae*) がグループ A で 60%、グループ B で 40%、グループ C で 64% とすべてのグループで有意を示していた。ヤケヒョウダニ (*D. pteronyssinus*) はグループ A、B、C でそれぞれ 45%、35%、48% で見られた。イヌのいる家庭 (グループ A と B) といない家庭 (グループ C) で有意差は認められなかった。サンプリング場所を検討すると、ハウスダストマイトが頻繁に復帰する率はグループ A がグループ B に比べて高かった ($P = 0.044$)。またグループ A よりもグループ B でイヌの睡眠スペースでのダニの頻度 ($P = 0.011$) と密度 ($P = 0.015$) の両方が高値をしめしていた。結論として、ハウスダストマイトの存在と濃度は臨床的に健康な非アトピー犬のマイクロ環境に比べ、ダニ過敏症アトピー性皮膚炎犬のマイクロ環境で高いことが言える。