Food and Chemical Toxicology 66 (2014) 329–333

Contents lists available at ScienceDirect

Food and Chemical Toxicology

journal homepage: www.elsevier.com/locate/foodchemtox

Association between passive smoking and atopic dermatitis in dogs

D. Ka [a,1], G. Marignac [a,*], L. Desquilbet [b,2], L. Freyburger [c,3], B. Hubert [a,1], D. Garelik [d,4], S. Perrot [e,2]

[a] Université Paris-Est, Ecole Nationale Vétérinaire d'Alfort, Unité de Parasitologie-Mycologie Dermatologie, CHUVA, 7 avenue du général de Gaulle, 94704 Maisons-Alfort Cedex, France
[b] Université Paris-Est, Ecole Nationale Vétérinaire d'Alfort, Unité épidémiologie des maladies animales infectieuses ENVA USC ANSES, Maisons-Alfort F-94704, France
[c] Université de Lyon, VetAgro Sup, F-69280, EA 4174, Sepsis, Inflammation et Hémostase, Marcy l'Etoile, France
[d] Unité de Tabacologie, Service de Pneumologie, AP-HP, G.H.U. Pitié Salpêtrière, Paris, France
[e] Université Paris-Est, Ecole Nationale Vétérinaire d'Alfort, IRCA, 7 avenue du général de Gaulle, 94704 Maisons-Alfort Cedex, France

ARTICLE INFO

Article history:
Received 9 October 2013
Accepted 10 January 2014
Available online 31 January 2014

Keywords:
Atopic dermatitis
Smoking
Tobacco
Second-hand smoking
Third-hand smoking
Canine

ABSTRACT

Onset of atopic dermatitis and occurrence of related skin lesions are influenced by various environmental factors in humans, and companion animals. Several studies have demonstrated an association between passive smoking and the development of atopic dermatitis in children. This association has never been investigated in the dog to our knowledge.

We enrolled 161 dogs seen at dermatology and vaccination consultations over a six-month period for this study. Dog owners were asked to complete a questionnaire, to evaluate the exposure of the dog to tobacco smoke. The atopic or non-atopic status of the dog was assessed on the basis of Favrot's criteria (history, clinical examination and cutaneous cytology for Malassezia).

Analysis of the data for the 161 dogs enrolled revealed a significant association between high levels of passive exposure to tobacco smoke (cigarette consumption divided by the area of the home) and the presence of atopic dermatitis in the dogs (OR, 4.38; 95% CI, 1.10–17.44; $p = 0.03$; NNH (number needed to harm) 3, 95% CI 2–52). The prevalence of atopic dermatitis showed a slight, but non-significant association with breed predisposition.

Dogs with high levels of exposure to tobacco smoke may have a higher risk of atopic dermatitis than non-exposed dogs.

1. Introduction

About one billion people worldwide smoke (OMS-WHO, 2009). The most recent studies have tended to show an association between the development of atopic dermatitis in infants and passive exposure to tobacco smoke (Kramer et al., 2004; Bohme et al., 2010; Hansen et al., 2010), although some studies have reported inconclusive results (Ownby and McCullough, 1988; Strachan and Cook, 1998; Hjern et al., 2001; Hancox et al., 2008).

Atopic dermatitis affects up to 10% of dogs and, like the human form of the disease, is characterised by marked pruritus and skin rash, chronicity together with acute flare-ups of cutaneous symptoms. In dogs, it begins in young adults and persists throughout the animal's life, whereas, in humans, it begins in early infancy and leads to the so-called "atopic march" (Hillier and Olivry, 2004). It is difficult to differentiate clinically between atopic dermatitis and food allergy in dogs (Hillier and Griffin, 2001; Favrot et al., 2010). In both species, atopic dermatitis is highly heritable, with a strong familial component, but environmental and immunological factors also play critical roles in determining the clinical phenotype of atopic dermatitis. An indoor lifestyle is strongly associated with the development of the disease in dogs (Favrot et al., 2010). House dust mites are the allergens most frequently implicated in human atopy, but a role for pollutants, such as tobacco smoke, which concentrates in indoor environments, has also been suspected (Strachan and Cook, 1998; Kramer et al., 2004; Hancox et al., 2008; Bohme et al., 2010; Hansen et al., 2010).

Passive smoking is the result of second-hand and third-hand smoking. Second-hand smoking is the inhalation, by a non-smoker, of the mixture of sidestream smoke given off by a smouldering

* Corresponding author at: Université Paris-Est, Ecole Nationale Vétérinaire d'Alfort, Unité de Parasitologie-Mycologie Dermatologie, CHUVA, 7 avenue du général de Gaulle, 94704 Maisons-Alfort Cedex, France. Tel.: +33 1 43 96 70 61; fax: +33 1 43 96 71 90.

E-mail addresses: reithefirst@hotmail.com (D. Ka), gmarignac@vet-alfort.fr (G. Marignac), ldesquilbet@vet-alfort.fr (L. Desquilbet), ludovic.freyburger@vetagro-sup.fr (L. Freyburger), blaise.hubert@orange.fr (B. Hubert), dangarelik@aol.com (D. Garelik), sperrot@vet-alfort.fr (S. Perrot).

[1] Tel.: +33 1 43 96 70 61; fax: +33 1 43 96 71 90.
[2] Tel.: +33 1 43 96 70 00; fax: +33 1 43 96 71 90.
[3] Tel.: +33 4 78 87 56 61.
[4] Tel.: +33 1 42 16 78 84.

http://dx.doi.org/10.1016/j.fct.2014.01.015
0278-6915/

cigarette and of the mainstream smoked exhaled by a smoker (Winickoff et al., 2009). Third-hand smoke includes a mixture of semi-volatile compounds found in second-hand smoke that settle on or stick to the surfaces of an indoor space and are subsequently released back into the air. Third-hand smoke also includes particulate matter deposited and accumulating on surfaces and in dust, or trapped in carpets, upholstery, fabrics and other porous materials commonly found in indoor environments (Kramer et al., 2004). This type of passive smoking may be the most relevant for pets, as already suggested for human infants, as these two groups have similar risk factors: they often rest on indoor fabrics or carpets, they have a tendency to bite or suck non-food items, they inhale and ingest more dust than human adults as they are closer to the floor, and they have narrow respiratory tracts (Winickoff et al., 2009; Matt et al., 2011) with a higher rate of respiration relative to body size. Ingestion is thought to be the main source of exposure to third-hand smoke particles in children, as their rates of dust ingestion are more than twice those of adults. Dogs would be expected to have an even greater exposure to the harmful components of third-hand smoke than children, due to their tendency to lick themselves (Roberts and Dickey, 1995).

The aim of this study was to investigate the association between passive smoking and the development of Atopic dermatitis in adult dogs.

2. Materials and methods

This study was a cross-sectional study that was carried out during dermatology and vaccination consultations at the ENVA veterinary hospital over a six-month period beginning in September 2010. All dogs that were presented at dermatology and vaccination consultations were enrolled after a written informed consent was obtained from the owners. A questionnaire was developed and submitted to owners presenting their dog at a dermatology or vaccination consultation. At the beginning of each dermatology consultation, owners are asked where their dog sleep (garage, kennel, sofa, owner's bed).

Atopic dermatitis was diagnosed once parasitic causes were ruled out (e.g. sarcoptic mange, flea infestation or allergy, demodicosis). A dog was considered to suffer from atopic dermatitis if six of the eight criteria proposed by Favrot et al. were met (Favrot et al., 2010). Assessments of the presence or absence of these criteria were based on the animal's history, collected through the questionnaire (presence of pruritus, age at onset, amount of time spent indoors, response of pruritus to corticosteroid treatment and history of Malassezia infection), and physical examination. Physical examination was carried out immediately after completion of the questionnaire, by the same investigator. Lesions affecting the front feet, ear pinnae, ear pinna margins and dorsolumbar area were noted. After physical examination, the skin was sampled for the presence of Malassezia, by the acetate tape method applied to both axillae, both inguinal areas, and a skin lesion, if present (Bensignor et al., 2002; Machado et al., 2011).

Tobacco exposure was assessed solely on owners declaration through four questions in the questionnaire: (#1) "Is there at least one person in your home that has been smoking for at least one year?", (#2) "Is the animal present when someone smokes in your home or in the car (even if the windows are open)?", (#3) Daily tobacco consumption at home and in the car, classified into four categories for smokers: >0–2 cigarettes/day (cig/d), 3–10 cig/d, 11–20 cig/d and 21 or more cig/d, and (#4) area of the home in square metres (m^2).

The consumption of tobacco other than cigarettes (pipe tobacco, cigars, cigarillos, etc.) was converted into cigarette-equivalents (CE) as described by Boffeta and co-workers (Boffetta et al., 1999), considering the mean tobacco content of a cigarette to be 1 g. Passive smoking was then investigated through two indicators: (1) exposure to tobacco consumption (number of CE consumed per day, classified into five categories, including "unexposed"), and (2) smoke exposure (tobacco consumption divided by the area of the home). Smoke exposure was recoded into five categories (referred to hereafter as "levels"): level 0, corresponding to unexposed dogs, and four levels based on the quartiles of smoke exposure among exposed dogs as cut-off points.

A dog was considered not to be exposed to passive smoking if the owner answered "no, never" to the question #1. A dog was considered to be exposed to passive smoking if the owner answered "yes, for more than a year" to both questions #1 and #2. These questions were designed to exclude intermittent or recent (less than one year) exposure to passive smoking.

In addition to the information regarding allergy and passive smoking obtained through the questionnaire, the following historical and clinical data were recorded for each dog: breed, current age, sex, age at onset, clinical signs, and type of consultation attended (dermatology or vaccination). Based on the literature and our clinical records, the following breeds were considered to have a predisposition to atopic dermatitis: Labrador retriever, American Staffordshire terrier, German shepherd, Jack Russell terrier, Golden retriever, French bouledogue, West Highland White Terrier (WHWT), Sharpei, Boxer, Dalmatian, English Cocker spaniel, American Cocker spaniel (Scott, 1981; Halliwell and Gorman, 1989; Carlotti and Costargent, 1994).

Raw data were entered using EpiData software version 3.1 (http://www.epidata.dk). Statistical analyses were performed with Epi-Info software version 3.5.3 (CDC, Atlanta, GA, USA). To compare allergic with non-allergic dogs, chi-squared tests were used for qualitative variables and Wilcoxon tests were used for quantitative variables. Although the present study did not assess a treatment effect, individuals exposed to passive smoking are also impregnated by a foreign substance. Besides the provided crude and adjusted OR, Number-Needed-To-Harm (NNH) (McQuay and Moore, 1997) was calculated to illustrate the association with passive smoking.

Two multivariate logistic regression models were used to analyse the association between passive smoking and allergy. In addition to potential confounding factors, the first model included exposure to tobacco consumption and the second included the level of smoke exposure. The potential confounding factors considered were sex, age at presentation, and breed (predisposed vs not predisposed). We explored the shape of the dose–response association with smoke exposure considered continuously, by using restricted cubic spline functions in the multivariate logistic regression model (Desquilbet and Mariotti, 2010).

The type-1 error was set at 5%, and all statistical tests were two-tailed.

3. Results

In total, 219 dogs were enrolled between September 2010 and April 2011. Fifty-eight dogs were excluded due to (1) intermittent/recent exposure to passive smoking ($n = 30$ dogs) or

Table 1
Baseline characteristics as a function of the presence or absence of atopic dermatitis in 161 dogs.

Baseline characteristics	Total ($N = 161$)	Dogs with AD ($n = 78$)	Dogs free of AD ($n = 83$)	p-Value
Males, n (%)	94 (58)	46 (59)	48 (58)	0.88
Median age [IQR]	5 [3–9]	5 [3–9]	6 [4–10]	0.09
Predisposed breed, n (%)	84 (52)	46 (59)	38 (46)	0.09
Passive smoking				
Tobacco consumption, n (%)				
0 cig/d (unexposed dogs)	91 (57)	40 (51)	51 (61)	0.62
> 0–2 cig/d	7 (4)	4 (5)	3 (4)	
3–10 cig/d	17 (10)	8 (10)	9 (11)	
11–20 cig/d	32 (20)	17 (22)	15 (18)	
> 20 cig/d	14 (9)	9 (12)	5 (6)	
Level of smoke exposure, n (%)				
Level 0 (unexposed dogs)	91 (56)	40 (51)	51 (61)	0.24
Level 1	21 (13)	9 (12)	12 (15)	
Level 2	17 (11)	9 (12)	8 (10)	
Level 3	19 (12)	10 (13)	9 (11)	
Level 4	13 (8)	10 (13)	3 (4)	

Notes: AD, atopic dermatitis; IQR, interquartile range.