

Mite and pet allergen exposure in Brazilian private cars

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Background: The role of mite and pet allergens in the development of allergic diseases has been recognized for many years.

Objective: To determine mite (*Dermatophagoides pteronyssinus* [Der p 1] and *Dermatophagoides farinae* [Der f 1]), cat (*Felis domesticus* [Fel d 1]), and dog (*Canis familiaris* [Can f 1]) allergen levels in Brazilian private cars.

Methods: Mite, cat, and dog allergens were measured in dust samples collected from 60 upholstered seats of private vehicles using enzyme-linked immunosorbent assays.

Results: Mean levels of Der p 1 (0.24 $\mu\text{g/g}$ of dust; range, 0.06–2.05 $\mu\text{g/g}$ of dust) and Der f 1 (0.29 $\mu\text{g/g}$ of dust; range, 0.06–2.07 $\mu\text{g/g}$ of dust) were extremely low in most dust samples analyzed. In contrast, sensitizing mean levels of Can f 1 (1.51 $\mu\text{g/g}$ of dust; range, 0.14–30.96 $\mu\text{g/g}$ of dust) and Fel d 1 (0.43 $\mu\text{g/g}$ of dust; range, 0.02–5.75 $\mu\text{g/g}$ of dust) were observed in 32 (53%) and 12 (20%) samples, respectively. Mean Can f 1 levels were significantly higher in cars whose owners kept dogs at home (3.27 $\mu\text{g/g}$ of dust) than in those without pets (0.57 $\mu\text{g/g}$ of dust; $P = .008$). There were no significant differences in allergen levels regarding the age of the vehicle or the number of users and whether the owners transport pets inside the vehicles.

Conclusions: Private cars constitute an important pet, but not mite, allergen reservoir for continuous contamination of the indoor environment. Pet allergens may be present even in cars whose owners do not have pets. Effective measures to reduce allergen exposure in cars should be taken routinely, especially for pet-allergic patients.

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INTRODUCTION

In recent decades, there has been a global increase in the prevalence of allergic diseases associated with a change in the lifestyle of modern societies.¹ Mites and pets are important sources of indoor allergens,² and their role in the development of allergic diseases has been recognized for many years.³ Besides homes, public places such as day-care centers and schools,⁴ hospitals,⁵ cinemas,⁶ and public transport vehicles⁷ have been considered important mite and pet allergen reservoirs for continuous contamination of the indoor environment. The presence of allergens in public places is mainly due to passive allergen transport on clothing, and environmental factors such as temperature and relative humidity can affect mite allergen levels.^{8,9}

It is widely recognized that exposure levels of 2 $\mu\text{g/g}$ of dust or more of *Dermatophagoides pteronyssinus* (Der p 1) or *Dermatophagoides farinae* (Der f 1) allergens and 1 $\mu\text{g/g}$ of

dust or more of cat (*Felis domesticus* [Fel d 1]) or dog (*Canis familiaris* [Can f 1]) allergens are considered risk factors for allergenic sensitization in genetically predisposed individuals.¹⁰ The aims of this study were to determine the levels of Der p 1, Der f 1, Fel d 1, and Can f 1 allergens in private cars and to investigate the relationship between allergen levels in cars and pet ownership.

METHODS

Dust Sampling and Allergen Extraction

Private cars from 60 university student or staff owners were randomly selected in the parking lot at the Federal University Campus of Uberlândia, Brazil, and enrolled in a study on allergen exposure. Informed consent was obtained from all car owners. A questionnaire regarding the age of the vehicle, the number of users, whether the car owners keep pets at home, and the habit of transporting pets in the car was completed by the car owners.

Composite dust samples were obtained from car seats (driver's seat and passenger's front and rear seats) by using a portable vacuum cleaner (Car Vac Plus; Black & Decker Inc, Hunt Valley, MD) adapted with a paper filter for dust retention for approximately 3 minutes in each vehicle (0.1–0.5 g of dust). Dust sampling was performed between January 8, 2001, and June 29, 2001, with the temperature ranging from 20.2°C to 25.1°C (mean $\pm$ SD, 23.2°C $\pm$ 2.2°C) and relative humidity ranging from 64% to 74% (mean $\pm$ SD, 69.2% $\pm$ 4.4%). All sampled seats were upholstered, and their surfaces

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were coated by cushion and woven fabrics. The same investigator (C.M.J.) performed all the dust sampling.

Fine dust was obtained by sieving through a 0.3-mm mesh screen (US Standard Sieve Series ASTM). Allergens were extracted from 100 mg of fine dust in 2 mL of 5-mmol/L borate-buffered saline solution (pH 8.0) overnight at 4°C. After centrifugation for 10 minutes at 10,000g, supernatants were stored at -20°C before immunoassays.

Enzyme-Linked Immunosorbent Assays for Measuring Mite and Pet Allergen Levels

Group 1 *Dermatophagoides* (Der p 1 and Der f 1), cat (Fel d 1), and dog (Can f 1) allergens were measured using enzyme-linked immunosorbent assays as described elsewhere¹¹ and their respective capture monoclonal antibodies: anti-Der p 1 (clone 5H8), anti-Der f 1 (clone 6A8), anti-Fel d 1 (clone 6F9), and anti-Can f 1 (clone 6E9F9). The detection antibodies consisted of biotinylated anti-group 1 *Dermatophagoides* allergens (clone 4C1) or anti-Fel d 1 (clone 3E4C4) monoclonal antibodies or polyclonal rabbit serum against Can f 1. Absorbance results are expressed in micrograms per gram of dust as described previously,¹¹ and the detection limit of the assay was 0.04 µg/g of dust for mite, 0.01 µg/g of dust for Fel

d 1, and 0.08 µg/g of dust for Can f 1 allergens. All allergen measurements were performed on 2 different days, and the coefficients of variation of the interassays were less than 6% for all allergens.

Statistical Analysis

Allergen concentrations were log transformed to normalize the distribution and are expressed as the geometric mean (gm) with the 95% confidence interval (CI). Differences between the means were analyzed using the unpaired *t* test, and *P* < .05 was regarded as statistically significant.

RESULTS

The pet ownership distribution related to the 60 car dust samples was 20, 19, 11, and 10 for individuals with no pets, dogs, cats, and both cats and dogs, respectively. Mite allergen levels were found at very low levels, and only 1 sample (2%) contained more than 2 µg of Der p 1 or Der f 1 per gram of dust (Fig 1A). However, sensitizing levels of Can f 1 (≥1 µg/g of dust) were observed in 32 samples (53%), of which 11 (18%) contained more than 10 µg of Can f 1 per gram of dust; 12 samples (20%) contained at least 1 µg of Fel d 1 per gram of dust. The mean level of Can f 1 (gm, 1.51 µg/g of

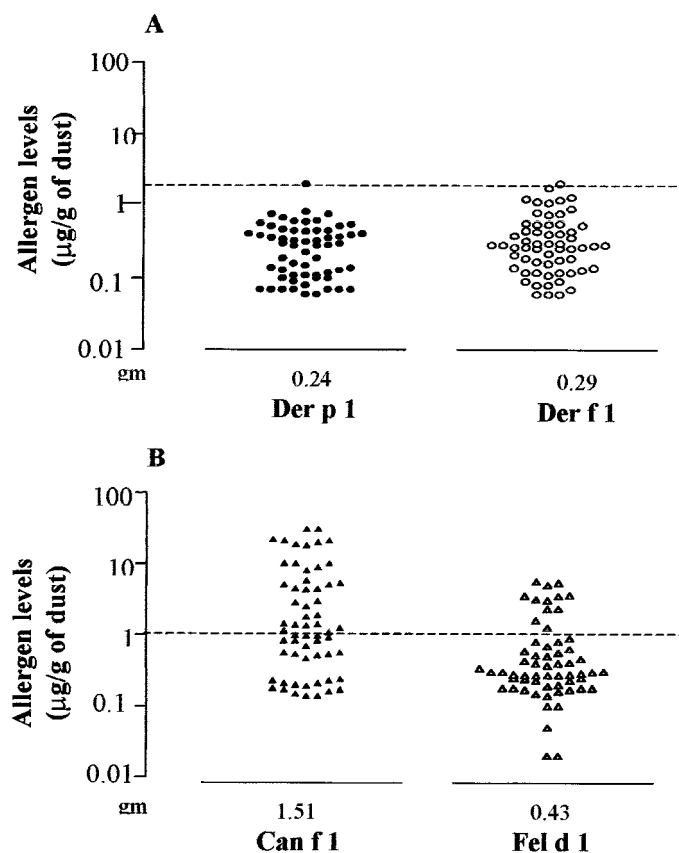


Figure 1. Levels of mite (*Dermatophagoides pteronyssinus* [Der p 1] and *Dermatophagoides farinae* [Der f 1]) (A) and pet (*Canis familiaris* [Can f 1] and *Felis domesticus* [Fel d 1]) (B) allergens in 60 dust samples from private cars. The dashed lines indicate levels considered to be risk factors for allergenic sensitization in genetically predisposed individuals (2 µg/g of dust for mite allergens and 1 µg/g of dust for pet allergens); gm, geometric mean.

dust; 95% CI, 1.01–2.31 $\mu\text{g/g}$ of dust) but not of the other allergens tested was greater than the risk factor for allergic sensitization in susceptible individuals (Fig 1B).

Levels of Can f 1 were significantly higher in cars belonging to dog owners (gm, 3.27 $\mu\text{g/g}$ of dust; 95% CI, 1.80–6.13 $\mu\text{g/g}$ of dust) than in those belonging to non-pet owners (gm, 0.57 $\mu\text{g/g}$ of dust; 95% CI, 0.36–0.89 $\mu\text{g/g}$ of dust) or cat-only owners (gm, 0.84 $\mu\text{g/g}$ of dust; 95% CI, 0.28–2.49 $\mu\text{g/g}$ of dust) ($P = .02$ for both) (Fig 2). Among 29 dust samples from cars belonging to dog owners, 22 samples (76%) contained at least 1 μg of Can f 1 per gram of dust, of which 10 samples (34%) contained at least 10 μg of Can f 1 per gram of dust. In contrast, the mean Fel d 1 levels were below the threshold levels for sensitization in car dust samples of cat and non-cat owners. Sensitizing levels of Can f 1 were found in cars of non-pet owners, with 5 (25%) and 1 (5%) of 20 samples containing Can f 1 and Fel d 1, respectively, above the sensitization threshold levels (Fig 2).

When analyzing the number of dogs in the residence, 23 (79%) of 29 dust samples from cars belonging to dog owners were related to the presence of only 1 dog in the residence. Of 6 samples (21%) related to the presence of 2 or more dogs, 4 (67%) had sensitizing levels of Can f 1. Among dog owners, the transportation of pets in cars did not result in statistically significant increases in pet allergen levels in cars. The mean level of Can f 1 in cars transporting dogs was 5.88 $\mu\text{g/g}$ of dust (95% CI, 2.28–15.20 $\mu\text{g/g}$ of dust), whereas the mean Can f 1 level in cars not transporting dogs was 2.22 $\mu\text{g/g}$ of

dust (95% CI, 0.97–5.07 $\mu\text{g/g}$ of dust; $P = .11$). There were no significant differences in mite or pet allergen levels according to the age of the vehicle or the number of users, although higher allergen levels were found in older vehicles (data not shown).

DISCUSSION

The development and phenotypic expression of allergic airway diseases greatly depends on the complex interactions between genetic and environmental factors, such as air pollution, diet, infections, and, particularly, inhalant allergens.¹² In modern society, individuals spend a large part of their time indoors and more than 5% of their time inside transport vehicles.¹³ In addition to mite and pet allergen exposure at home, the presence of these allergens in vehicles can contribute to sensitization induction in susceptible individuals or symptoms in patients with allergic respiratory diseases. In the present study, Der p 1 and Der f 1 allergens were detected at very low levels, as reported in a study¹⁴ on mite allergens in public transport vehicles performed in Finland. This finding is probably due to the unfavorable conditions of high temperature and low air humidity for mite growth inside private cars that result from parking in sunny places with the windows closed. Mite allergen levels in taxis, on the other hand, are significantly higher because they are often stationed in shady places with the windows opened, thus providing more favorable conditions for mite breeding.⁷

Keeping indoor dogs is more common than indoor cats among the Brazilian population,¹⁵ which may explain the

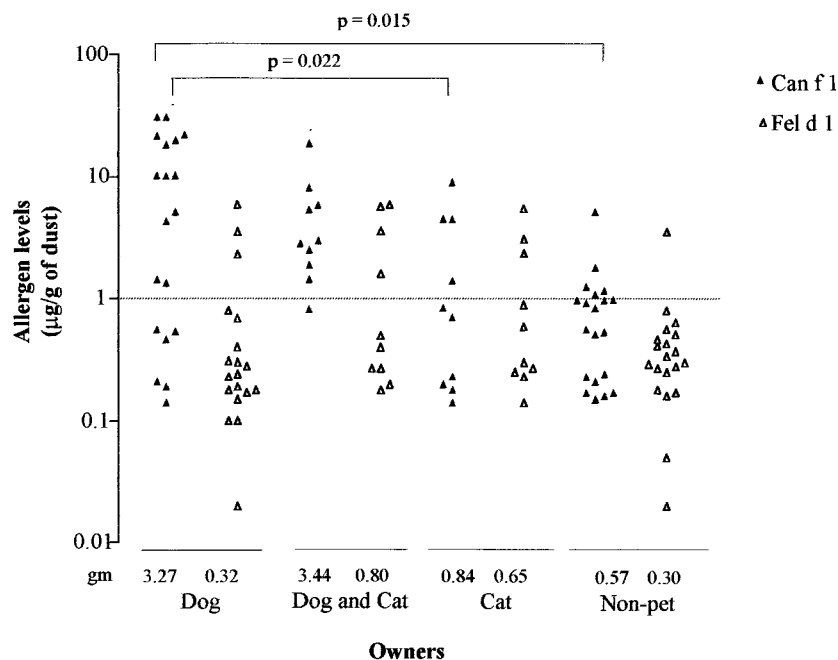


Figure 2. Levels of *Canis familiaris* (Can f 1) and *Felis domesticus* (Fel d 1) allergens in dust samples from cars of pet and non-pet owners. The dashed line indicates the level considered to be a risk factor for allergenic sensitization in genetically predisposed individuals (1 $\mu\text{g/g}$ of dust for pet allergens); gm, geometric mean.

high levels of Can f 1 allergen found in our car dust samples. More than 50% of the samples analyzed showed sensitizing levels ($\geq 1 \mu\text{g/g}$ of dust) of Can f 1, whereas Fel d 1 allergen was detected at sensitizing levels in only 20% of the samples. In addition, exacerbating levels of allergic symptoms ($\geq 10 \mu\text{g/g}$ of dust) of Can f 1 were found in 11 samples (18%). Our findings are in agreement with those of previous studies^{14,16} that have shown significant levels of dog and cat allergens in different public places and in public transport vehicles in England, Finland, and Sweden.

A strong association was observed between Can f 1 levels in car dust samples and dog ownership. Ten of 11 samples with levels of Can f 1 of at least $10 \mu\text{g/g}$ of dust were related to dog ownership, but only 1 of them had 2 or more dogs in the residence. Thus, exacerbating levels of Can f 1 seem not to be associated with the number of dogs in the residence. However, we did not demonstrate the same association for cat allergens. Such a finding could be due to the singular feature of the Fel d 1 allergen of widespread dissemination that remains airborne for long periods, mainly in still indoor environments.¹⁷ Another probable explanation could be the small number of dust samples from cars belonging to cat owners in the present study. In vehicles of dog owners, no significant association was found between Can f 1 levels and whether dogs were transported in the vehicles. In addition, we detected Can f 1 and Fel d 1 allergens in 25% and 5% of dust samples, respectively, from cars whose owners do not have pets. These results support the hypothesis that the presence of pet allergens in cars is due to passive allergen transport on clothing, shoes, or ventilation, as shown for allergen transport in public places.^{8,9}

We conclude that upholstered seats in Brazilian private cars constitute an important pet, particularly dog, allergen reservoir for continuous contamination of the indoor environment. This study demonstrates that besides homes and several public places, pet allergens can also be found in private cars. In addition, the presence of pet allergens even in cars of non-pet owners should be considered, and effective measures for the reduction of allergen exposure in cars should be accomplished routinely, especially for pet-allergic patients.

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