

Short communication

Occurrence of dog, cat, and mite allergens in public transport vehicles

Background and Methods: Helsinki City Transport buses, trams, and underground trains carry 687 000 passengers on a weekday. Of the passengers, 0.13% travel with a pet. We interviewed passengers and measured allergen levels in vehicles to determine what difficulties allergens cause to passengers with allergy and asthma.

Results: Of 2021 interviewed passengers, 14% complained about inconvenience caused by pets, usually health problems. Of 324 adult passengers with allergy or asthma, 53% had experienced symptoms in public transport; the corresponding figure for 75 children was 32%. The median concentration of the main dog allergen, Can f 1, in dust from seats and floors in public transport vehicles was 2400 ng per g of dust (range 20–8500 ng/g). For the main cat allergen, Fel d 1, the median was 870 ng/g (range 3–2600 ng/g). These levels can be regarded as low or moderate, and they cause symptoms in sensitive persons. Concentrations of mite allergens were undetectable or low. Allergen levels were lower in vehicles where pets were not allowed than in vehicles where pets were allowed, lower in dust from uncovered seats than in dust from seats with a covering, and lower after cleaning vehicle floors and seats than before cleaning.

Conclusions: Dog and cat allergens are present in public transport vehicles in Helsinki at levels that cause symptoms in sensitive persons. Prohibiting pets would probably bring only a modest reduction in levels, as few pets are carried, and much allergen contamination comes from passengers' clothes.

K. Partti-Pellinen, O. Marttila

South Karelia Allergy and Environment Institute,
Tiuruniemi

S. Mäkinen-Kiljunen, T. Haahtela

Department of Allergology, Skin and Allergy Hospital,
Helsinki University Hospital, Helsinki, Finland

Key words: allergens; cat; dog; mite; public transport

Kirsi Partti-Pellinen

South Karelia Allergy and Environment Institute
FIN-55330 Tiuruniemi
Finland

Accepted for publication 28 June 1999

Public indoor environments such as schools, day-care centres, hotels, cinemas, and public transport vehicles contain allergen reservoirs, which can cause significant exposure to dog, cat, and mite allergens (1–4). Allergens in public transport vehicles could be a significant problem, as large populations travel in them daily; Helsinki City Transport buses, trams, and underground trains carry 687 000 passengers on a weekday. The vehicle-operating staff numbers 1200. Pets are permitted, and some 900 passengers (0.13%) per day travel with a pet.

In the present study, we assessed, by means of interviews and questionnaires, the inconvenience caused by pets and allergens to passengers. We also measured dog, cat, and mite allergen concentrations in dust samples collected in vehicles.

Material and methods

Interviews and questionnaires

We interviewed 2021 adult persons travelling in Helsinki City Transport buses, trams, and underground trains from January to April 1996. Every seventh person refused to be interviewed, usually because his or

her trip was short. Questions were asked about use of public transport, pets at home, opinion about pets on public transport, inconvenience caused by the pets to the interviewees or their children, and allergies of the interviewees and their children.

Interviewees who suffered from allergy or asthma or who were inconvenienced by pets on public transport were given a questionnaire to be completed and returned by mail. The number of such adults' questionnaires handed out was 751; of these, 56% were returned. Parents who had children with allergy or asthma, or whose children were troubled by pets on public transport, were given the children's questionnaire. The number given was 158, and 47% of them were returned. Questions concerned allergy and asthma symptoms, pets at home, respiratory infections, smoking habits, and opinions about pets and cleanliness on public transport.

The populations are characterized in Table 1.

Allergens in dust from public transport vehicles

Helsinki buses have upholstered, cloth-covered seats; trams, semihard, cloth-covered seats; and underground trains, uncovered plastic seats. Vehicle floors are

Table 1. Characterization of populations

Characteristics	Adults who were interviewed	Adults who answered questionnaire	Children with parents who answered children's questionnaire
Number of persons	2021	424	75
Sex			
Female (%)	65	77	52
Male (%)	35	23	48
Allergy or asthma (%)	30	76	60
Smoker (%)		17	
Pet at home (%)	26	21	30

dry-vacuumed daily. A wet vacuuming of floors is carried out every 3 or 4 weeks; simultaneously, tram seats are vacuumed and train seats wiped off. Tram seats are washed once a year, bus seats as needed. Pets are allowed on all Helsinki transport vehicles with the exception of every second car in underground trains; these cars have “No pets” signs.

In February 1996, 18 dust samples were collected from seats and floors of vehicles. To collect a sample, a surface of 5 m² was vacuumed with a 1200-W vacuum cleaner for 5 min with a device that passed the air through a Millipore filter with a pore size of 6 µm (ALK, Denmark), on which the sample was deposited. To get a sufficient sample from train seats, an area of 25 m² was vacuumed. Samples were stored at –20°C until analysis.

The allergens assayed from the dust samples were the major allergens of dog (Can f 1); cat (Fel d 1); and the three dust mites *Dermatophagoides pteronyssinus* (Der p 1), *D. farinae* (Der f 1), and *D. microceras* (Der m 1). Assays were carried out by ALK in Denmark with the enzyme-linked immunosorbent assay and monoclonal or monospecific antibodies to the major allergens, as previously described (1).

Statistical methods

The chi-square test was used to calculate the significance (*P* values) of differences between studied

passenger groups. Allergen concentrations are given as medians and ranges.

Results

Complaints about pets

Of the 2021 persons interviewed, 14% reported that pets on public transport caused inconvenience. Among those who complained, 58% found animals detrimental to their health – they usually had allergy or asthma – 21% experienced animals as frightening, 16% found animals unpleasant, and 5% had some other complaint. Of the interviewees, 30% suffered from allergy or asthma, and 26% had a furred or feathered pet at home (Table 1). Of those with allergy or asthma, 19% had a pet.

Fifty-one per cent of the passengers who had allergy or asthma and 57% of those with an allergic child were dissatisfied with the present system with few restrictions on the transport of pets. In the opinion of 31% and 36%, respectively, only exceptional pets should be permitted, such as the Seeing Eye dogs of blind persons.

Symptoms

Of the 424 passengers who filled in the questionnaire, 324 had allergy or asthma. Most of these persons reported that they experienced allergy and asthma symptoms when in contact with animals and when on public transport vehicles. The 100 persons who did not have allergy and asthma reported fewer symptoms, but – for instance – 12% experienced nasal symptoms in the presence of animals and 14% on public transport (Table 2).

When passengers were asked what caused the symptoms they had on public transport, both persons with and without allergy and/or asthma considered odours from fellow passengers as the most probable cause (62% and 52%, respectively). Among those with allergy and asthma, pets in vehicles placed second as the cause (41%), while few (15%) of those with no allergy or

Table 2. Symptoms of allergy and asthma. Passengers and parents of child passengers were asked about symptoms when in contact with animals and when on public transport vehicles

Symptoms	When in contact with animal			When on public transport		
	Group A Passengers with allergy or asthma	Group B Passengers with no allergy or asthma	Group C Children	Group D Passengers with allergy or asthma	Group E Passengers with no allergy or asthma	Group F Children
Number of persons	324	100	75	324	100	75
Cough (%)	16***	3	16	22*	13	13
Wheeze (%)	13***	1	8	4*	0	0
Feeling of tightness in chest (%)	9***	2	4	6*	0	1
Breathlessness (%)	17***	2	4	12**	2	1
Sneezing, runny or stuffy nose (%)	48***	12	37	34***	14	24
Itching or runny eyes (%)	43***	8	29	19**	6	13
Itching skin or eczema (%)	23***	3	16	5*	0	5
No symptoms (%)	31***	79	51	47***	72	68

Chi-square test was used to compare group A with group B, and group D with group E; significant differences observed: **P*<0.05, ***P*<0.01, ****P*<0.001.

Table 3. Probable causes given by passengers for allergy and asthma symptoms they experienced on public transport

Assumed cause of symptoms	Group A Passengers with allergy or asthma	Group B Passengers with no allergy or asthma	Group C Passengers with dog or cat at home
Number of persons	174	27	25
Odours from fellow passengers (%)	62*	52	76
Pet in vehicle (%)	41**	15	8
Tobacco or cigarette odour (%)	30	26	24
Airborne dust (%)	30	30	32
Too dry air (%)	21	19	36
Draught (%)	10	4	12
Too humid air (%)	0**	4	4
Other causes (%)	2**	11	4

Chi-square test was used to compare group A with group B; significant differences observed: * $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$.

asthma considered pets a probable cause of symptoms. Passengers with a dog or cat at home gave answers similar to those of passengers with no allergy or asthma (Table 3).

Allergen levels in vehicles

Dog and cat allergens were found in all seat and floor dust samples examined. The analysing laboratory (ALK, Denmark) described the concentrations observed (Table 4) as low or medium. Contents of *D. pteronyssinus* and *D. microceras* mite allergens were

low in all samples, less than 50 ng/g of dust. No *D. farinae* allergen was found.

Several factors appear to influence allergen levels in public transport vehicles: allergen levels were lower in dust from uncovered seats than in dust from seats with a covering, lower after cleaning vehicle floors and seats than before cleaning, and lower in vehicles where pets were not allowed than in vehicles where pets were allowed (Table 4).

Discussion

Dogs, cats, and, in suitable climates, mites are important sources of indoor allergens (1–4). Considerable cat and dog allergen concentrations have been found in dust from public environments, including public transport (2), in the UK (2, 3) and in Sweden (1). In Scandinavia, levels of the mite allergens observed are generally low (1, 5–7), and this was true also for the present study. Mite allergens do not – at least not in wintertime – affect the quality of indoor air on public transport. Thus, our study centred on the presence and the effects of dog and cat allergens.

It has been suggested that levels above 8000 ng of the cat allergen Fel d 1 per gram of dust pose both a risk of sensitization and a risk of acute asthma (8, 9). For the dog allergen Can f 1, levels above 10 000 ng/g have been suggested to be similarly detrimental (10). High concentrations of cat (mean 14 730 ng/g) and dog (mean 9400 ng/g) allergens have been reported in dust

Table 4. Factors affecting levels of dog and cat allergen on public transport vehicles. Dust samples were collected immediately before routine cleaning unless otherwise stated. Allergen amounts are given as nanograms per gram of dust

Factors studied and sites sampled	Dog allergen			Cat allergen		
	Number of samples	Median (ng/g)	Range (ng/g)	Number of samples	Median (ng/g)	Range (ng/g)
<i>All samples</i>						
Seats	8	2400	20–8500	8	870	3–2600
Floors	10	200	4–860	10	11	2–83
<i>Effect of pets – seats</i>						
Buses and trams, pets allowed	6	3800	20–8500	6	1300	3–2600
Underground trains, pets allowed	1	2000		1	70	
Underground trains, pets not allowed	1	280		1	42	
<i>Effect of pets – floors</i>						
Buses and trams, pets allowed	7	142	4–600	7	11	2–83
Underground trains, pets allowed	2	590	310–870	2	20	18–22
Underground trains, pets not allowed	1	200		1	9	
<i>Effect of seat material</i>						
Upholstered or cloth-covered seats	5	5400	2800–8500	5	1560	670–2600
Uncovered plastic seats	2	1100	280–2000	2	60	42–70
<i>Effect of cleaning – upholstered or cloth-covered seats</i>						
Seats before cleaning	5	5400	2800–8500	5	1560	670–2600
Upholstered seat after high-pressure washing	1	20		1	3	
<i>Effect of cleaning – floors</i>						
Floors before daily dry vacuuming	7	200	48–864	7	11	2–46
Floors after daily dry vacuuming	3	142	4–310	3	22	7–83

collected from upholstered seats on public transport in the UK (2).

The levels of cat (median 870 ng/g, maximum 2600 ng/g) and dog (median 2400 ng/g, maximum 8500 ng/g) allergen in dust from the floors and seats of public transport vehicles in Helsinki (Table 4) were lower than the risk limits and the levels observed in the UK. The Helsinki concentrations could still be detrimental, as the limits suggested are quite uncertain and low allergen levels may induce hyperreactivity (11, 12) and allergy symptoms.

When we interviewed 2021 passengers, 14% reported that animals on public transport caused them inconvenience. The percentage included 8% who said that pets were detrimental to their health, in most cases causing allergy or asthma. It may be noted that the population was large, and the response rate was high (86%).

Of 324 adult passengers who had allergy or asthma, 53% reported that they experienced symptoms on public transport, and 11% attributed the symptoms to animals. Parents with children who had allergy or asthma reported that 32% of the children experienced symptoms on public transport (Table 2). As the response rates to these questionnaires were only about 50%, passengers who did experience symptoms could be overrepresented, and these percentages could be somewhat too high.

The majority of those with allergy or asthma or with an allergic or asthmatic child wanted restrictions on the

transport of pets. Passengers with allergy and asthma considered pets to be the second most probable cause of symptoms; they considered odours from fellow passengers to be the main cause (Table 3).

In spite of the passengers' opinions, the relative importance of direct exposure to pets appears uncertain. Only 0.13% of passengers travel with a pet. Dog and cat allergens are carried onto public transport both by the pets and on the clothes of passengers and staff. It is known that much cat allergen can be carried on clothing (13, 14). As the concentrations of dog and cat allergens were 10–100 times higher in dust from covered seats than in dust from floors, it appears that the allergen contamination of covered seats caused by clothes of passengers is a major cause of exposure. Levels of animal allergen can probably best be lowered by using uncovered seats and by effective cleaning of vehicle floors and seats (Table 4). Washing the clothes of cat owners has been shown to be an effective method to prevent cat allergen dispersal (15).

Acknowledgments

This work was supported by Helsinki City Transport, the Helsinki Metropolitan Area Council, and the Ministry of Transport and Communications. We thank Fred Björkstén for his critical review during the preparation of the manuscript.

References

- MUNIR AKM. Exposure to indoor allergens and relation to sensitization and asthma in children. Linköping University, Medical Dissertation, No. 412, Linköping, Sweden, 1994:1–89.
- CUSTOVIC A, TAGGART SCO, WOODCOCK A. House dust mite and cat allergen in different indoor environments. *Clin Exp Allergy* 1994;**24**:1164–1168.
- CUSTOVIC A, GREEN R, TAGGART SCO, et al. Domestic allergens in public places. II. Dog (*Can f 1* and cockroach (*Bla g 2*) allergens in dust and mite, cat, dog and cockroach allergens in the air in public buildings. *Clin Exp Allergy* 1996;**26**:1246–1252.
- SOLOMON WR, MATHEWS KP. Aerobiology and inhalant allergens. In: MIDDLETON E JR, REED CE, ELIS EF, ADKINSON NF, YUNGINGER JW, editors. *Allergy: principles and practice*. St Louis, MO: CV Mosby, 1988:212–272.
- DYBENDAHL T, HETLAND T, VIK H, APOLD J, ELSAYED S. Dust from carpeted and smooth floors. I. Comparative measurements of antigens and proteins in dust vacuumed from carpeted and non-carpeted classrooms in Norwegian schools. *Clin Exp Allergy* 1989;**19**:217–224.
- DYBENDAL T, ELSAYED S. Dust from carpeted and smooth floors. V. Cat (*Fel d 1*) and mite (*Der p 1*, *Der f 1*) allergen levels in school dust. Demonstration of the basophil histamine release induced by dust from classrooms. *Clin Exp Allergy* 1993;**22**:1100–1106.
- WICKMAN M. Residential characteristics and allergic sensitization in children, especially to mites. Medical Dissertations, Karolinska Institute, Stockholm, Sweden, 1993:1–62.
- GELBER L, POLLART S, CHAPMAN MD, PLATTS-MILLS TAE, WILMINGTON DE. Serum IgE antibodies and allergen exposure as risk factors for acute asthma. *J Allergy Clin Immunol* 1990;**85**:193.
- WOODFOLK JA, LUCZYNSKA CM, DE BLAY F, CHAPMAN MD, PLATTS-MILLS TAE. Cat allergy [Editorial]. *Ann Allergy* 1992;**69**:273–275.
- INGRAM JM, SPORIK R, ROSE G, HONSINGER R, CHAPMAN MD, PLATTS-MILLS TAE. Quantitative assessment of exposure to dog (*Can f 1* and cat (*Fel d 1*) allergens: relationship to sensitization and asthma among children living in Los Alamos, New Mexico. *J Allergy Clin Immunol* 1995;**96**:449–456.
- DREBORG S. Very low allergen levels cause chronic bronchial hyperreactivity – a hypothesis. *Allergy Clin Immunol News* 1993;**5**:59–60.
- IHRE E, ZETTERSTRÖM O. Increase in non-specific bronchial responsiveness after repeated inhalation of low doses of allergen. *Clin Exp Allergy* 1993;**23**:298–305.
- ENBERG RN, SHAMIE SM, MCCULLOUGH J, OWNBY DR. Ubiquitous presence of cat allergen in cat-free buildings: probable dispersal from human clothing. *Ann Allergy* 1993;**70**:471–474.
- D'AMATO G, LICCARDI G, RUSSO M, BARBER D, D'AMATO M, GARREIRA J. Clothing is a carrier of cat allergens. *J Allergy Clin Immunol* 1997;**99**:577–578.
- LICCARDI G, RUSSO M, BARBER D, CARREIRA JD, D'AMATO M, DAMATO G. Washing the clothes of cat owners is a simple method to prevent cat allergen dispersal. *J Allergy Clin Immunol* 1998;**102**:143–144.