

## Short communication

# Pet-keeping in early childhood and airway, nose and skin symptoms later in life

**Background:** It is discussed whether exposure to pets during childhood is a risk or a protective factor for sensitization and allergic symptoms. The aim of this study was to investigate the association between pet-keeping at time of birth and allergic symptoms in airways, nose and skin among young children in Sweden. **Method:** A questionnaire was sent to the parents of 14 077 children (1–6 years), the focus being on allergic symptoms, home environment and other background factors including pet-keeping and avoidance behaviour. The response rate was 79%.

**Results:** Almost one-tenth of the population had got rid of pets because of allergy in the family, and 27.3% reported 'avoidance' behaviour towards pets. In a cross-sectional analysis current pet-keeping was 'protective', but this may be due to the fact that people avoid exposing their child to something that they believe is a risk factor for allergies. Pet-keeping at the time of birth was associated with 'wheezing', 'asthma' and 'rhinitis on pet-exposure' later in life for children from families with an 'avoidance' behaviour, and was not 'protective' for other children. There was also an indication of a dose–response relationship between the number of types of furred pets at time of birth and later symptoms in analyses adjusted for avoidance behaviour or current pet-keeping.

**Conclusion:** The distribution of pet-keeping in the population is largely explained by avoidance behaviour, meaning that those who have pets mainly are those who can stand them, indicating a 'healthy pet-keeping effect'.

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Key words: asthma; avoidance; pet-keeping; rhinitis.

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Accepted for publication 26 November 2002

Several recent articles have reported a 'protective' effect from exposure to domestic pets for sensitization and health effects such as asthma. Most of these studies have been of a cross-sectional design. However, the distribution of pet-keeping may be biased. Parents may avoid pets because they 'know' that such an exposure will increase the risk of allergies in the family. If so, a strong selection bias may be one of the explanations for the reported 'protective' effect of pet-keeping. The purpose of the present work is to study the importance of domestic pet-keeping for airway, nose, eye and skin symptoms among small children (1–6 years), and to study the bias introduced by active avoidance of pets.

## Method

This study is part of a large investigation on the indoor environment and its importance for health effects, such as allergies, among small children and their parents in Sweden, 'Dampness in Buildings and Health' (DBH). The first step was carried out in the year 2000 as a cross-sectional questionnaire study including the parents of all 14 077 children aged 1–6 years in the county of Värmland, Sweden.

The questionnaire was distributed by post, with three postal reminders.

The questionnaire included questions on, for example, the home, building dampness, breastfeeding, ETS exposure and food habits, besides questions on pet-keeping in the family. It was asked whether the family had pets now (current pet) and/or at the time of the child's birth or in between, and if so, what type of pet (cat, dog, hamster/rabbit, bird and fish). Furthermore, the parents were asked to state whether they had chosen not to have pets because of allergic diseases in the family ('an avoidance behaviour'), that is, whether they had avoided getting pets because of allergy in the family (yes/no), or had got rid of pets for the same reason (yes/no). The second part of the questionnaire included questions on the health of the child and the family. Allergic symptoms among children were collected with the same questions as used in the ISAAC study.

Associations between self-reported symptoms and environmental factors, including domestic pet-keeping, were estimated with logistic regression expressed as odds ratios (ORs) adjusted for confounders: gender, age, ETS exposure, length of breastfeeding period, allergic symptoms in family and type of building (single-family house vs multi-family). In further analyses, adjustments or stratifications for 'avoidance behaviour' and current pet-keeping were made. The local Ethics Committee approved the study.

## Results

Data on 10 851 children, corresponding to a response rate of 79%, were collected in the questionnaire study. The children came from 8918 families (homes) and 49.9% were girls. The age distribution was 1–2 years (18.6%), 2–3 years (18.4%), 3–4 years (19.5%), 4–5 years (21.1%), 5–6 years (22.3%). Of these children, 35.2% lived in rural, 55.6% in suburban and 9.1% in urban areas. Of the nonresponding families, 200 families were randomly selected. Of these, 116 families were reached by telephone. There were no significant differences in prevalence of symptoms among the children (i.e. wheezing, doctor-diagnosed asthma, eczema) or in frequency of building characteristics (i.e. type of building and suspected water/mould problem in the dwelling) between responding and nonresponding families.

At the time of the questionnaire study 42.3% of the families had a pet (current pet) and 44.0% had a pet at the time of the birth of the child. The most common pet indoors ('current') was cat (25.7%) followed by dog (18.2%), fish (6.9%), hamster/rabbit (6.6%) and bird (2.5%). The frequency of furred pets (cat, dog, hamster/rabbit) in the family increased significantly from 35% among the youngest children (1–2 years) to 44% among older children (5–6 years). There was a significant trend towards a higher frequency of getting rid of pets among older children (5–6 years) compared to younger children (1–2 years) (9.5 vs 6.7%, respectively). The prevalence of symptoms among the children is presented in Table 1.

Children who had pets at the time of birth or later but not current (14.5%) had the highest prevalence of all symptoms (Table 1). For example 'rhinitis on pet exposure' was two to six times more prevalent in this group compared to the other groups. This was true even when stratifying for age (data not shown). The second highest prevalence was in the group of children that never had any pets at home (44.5%). In the group of children with furred pets all the time (31.1%), that is, both at the time of birth and current, the prevalence was lowest for all symptoms.

However, these groups of families differ in many respects. Families without current pets report significantly more 'avoidance' (39.7 vs 7.7%) and more symptoms in the family (65.1 vs 45.0%) compared to families with current pets. The groups of children with avoidance behaviour reported a consistently high prevalence of symptoms (e.g. for 'rhinitis on pet exposure' 9.2, 6.8, 15.9 and 8.3%), significantly higher than the respective values for the 'no avoidance' groups of children (1.4, 0.9, 1.3 and 0.9%).

Overall, nearly one-tenth of the total population (8.5%) have got rid of pets because of allergy in the family and 27.3% of the total population reported avoidance behaviour (i.e. 'Got rid of pets due to allergy in the family' and/or 'Avoid getting pets due to allergy in

the family'). Of these 'avoidance' families, about 90% had at least one family member with reported allergic symptoms, as compared to about 40% in the 'nonavoidance group'. Of the children in the 'avoidance' families, 11.1% reported 'rhinitis on pet exposure', as compared to 1.1% for 'nonavoidance' families.

Analyses on the association between reported current pet-keeping and symptoms among children show, in general, that furred pets are significantly associated with a reduced risk of symptoms, with an adjusted OR of 0.23–0.82 (data not shown). Current pets were more 'protective' than pets at time for birth. Furthermore, cats were, in general, more 'protective' than dogs and rabbits. Neither bird nor fish at time of birth or current were associated with symptoms.

Pet-keeping at time of birth was 'protective' for current symptoms in crude and adjusted analyses (model I, Table 2). In analyses where the population was stratified for either 'current pet-keeping' or an 'avoidance' behaviour in the family, there was no longer a 'protective' effect of pet-keeping, except for 'cough during nights' and 'eczema' in nonavoidance families. Instead, pet-keeping is a 'risk' factor for 'wheezing last 12 months', 'asthma', 'rhinitis last 12 months' and 'rhinitis on pet exposure' for children without 'current' pets, and for children from 'avoidance' families. This increased 'risk' was found for families both with and without reported allergic symptoms (data not shown). Furthermore, after adjustments for an avoidance behaviour (model II, Table 2) or current pet-keeping (model III, Table 2), pet-keeping at time of birth was significantly associated with an increased prevalence of 'doctor-diagnosed asthma' and 'rhinitis on pet exposure'. In stratified analyses for the youngest children (1–3 years) and the oldest children (4–6 years), the same trends were found (data not shown).

Analyses on associations between the number of different types of pet (cat, dog and/or hamster/rabbit) at time of birth and current symptoms showed significant associations for a sub-group of symptoms (Table 3). In analyses with adjustments for avoidance behaviour (model II, Table 3) or current pet-keeping (model III, Table 3), there is indication of a dose–response relationship. The greater the number of different types of pet, the higher the prevalence of 'asthma' and 'rhinitis on pet exposure'. When only children aged 4–6 years were included in the analysis the same trend was found (model IV, Table 3).

## Discussion

As in many other cross-sectional or cohort investigations, this study shows that pet-keeping (mainly current pet-keeping) is 'protective' against allergic symptoms. However, the study indicates that the distribution of pet-keeping in the population is largely explained by active avoidance behaviour, meaning a potentially strong

Table 1. Prevalence of symptoms among 10 851 children (1–6 years) and avoidance behaviour in families in groups with different combinations of current and pet-keeping at time of birth

n (%)	Prevalence (%)											
	Never kept a pet (I)			Current pet-keeping; but not at birth (II)			Pet-keeping at birth or later but not current (III)			Pet-keeping both at birth and current (IV)		
	Total population	Avoid. behaviour*	No avoid. behaviour†	Total population	Avoid. behaviour*	No avoid. behaviour†	Total population	Avoid. behaviour*	No avoid. behaviour†	Total population	Avoid. Behaviour*	No avoid. behaviour†
10 851	4832 (44.5%)	92.2	38.9	858 (7.9%)	87.6	40.0	1571 (14.5%)	87.6	40.8	3380 (31.1%)	90.2	41.3
	4832 (44.5%)	1674 (56.5%)	3138 (40.9%)	858 (7.9%)	135 (4.6%)	698 (9.1%)	1571 (14.5%)	870 (29.4%)	695 (9.1%)	3380 (31.1%)	193 (6.5%)	3145 (41%)
Symptoms in family‡	54.2	92.2	38.9	48.3	85.9	40.0	66.7	87.6	40.8	44.2	90.2	41.3
Got rid of pets because of allergy in the family	8.5	—	—	5.4	34.3	0	49.4	89.3	0	2.5	43.8	0
Avoid getting pet because of allergy in the family	26.7	100	0	14.2	88.1	0	51.5	93.5	0	4.9	85.3	0
Exposed to pets elsewhere regularly	57.4	42.0	47.6	60.2	57.0	61.3	60.0	55.3	66.1	73.3	64.2	73.4
Wheezing last 12 months	19.3	29.2	13.9	16.9	21.2	15.7	27.0	36.3	15.7	15.7	28.4	15.0
Cough during nights	7.4	10.3	6.9	5.9	6.0	5.1	11.6	15.8	6.2	4.7	11.0	4.2
Asthma; doctor-diagnosed	5.4	11.5	2.1	4.1	4.6	3.8	11.2	17.6	3.3	2.8	11.2	2.2
Rhinitis last 12 months	11.2	17.2	8.9	8.1	13.0	6.8	18.9	26.0	10.2	7.4	17.0	6.7
Rhinitis on pet exposure	3.9	9.2	1.4	2.1	6.8	0.9	9.4	15.9	1.3	1.4	8.3	0.9
Rhinitis on pollen exposure	3.8	8.1	2.1	2.4	6.1	1.4	7.0	10.8	2.5	1.7	5.3	1.4
Allergic rhinitis; doctor-diagnosed	2.2	4.9	1.0	1.2	3.0	0.7	4.0	6.7	0.7	1.2	6.9	0.9
Eczema last 12 months	18.8	30.9	16.6	16.5	25.9	12.2	25.1	31.3	13.8	13.7	23.8	12.4

\* Families that avoid getting pets or have got rid of pets because of allergy in family.

† Families without avoidance behaviour.

‡ At least one symptom (asthma, hay fever, eczema) among family member other than the child.

Table 2. Association between furred pet-keeping at time of birth and reported symptoms among 10 851 children aged 1–6 years. Analysis adjusted in different ways and stratified for current pet-keeping and avoidance behaviour

Symptoms	OR (95 % CI)								
	Crude Total population	Model I*						Model II† Total population	Model III‡ Total population
		Total population	Current furred pet-keeping		Avoidance behaviour§				
			Yes	No	Yes	No			
<i>n</i>	10 636	9895	3880	6015	2707	7035	9747	9895	
Wheezing last 12 months	0.86 (0.78–0.95)	0.91 (0.82–1.01)	0.81 (0.65–1.01)	1.31 (1.11–1.54)	1.27 (1.04–1.54)	1.07 (0.93–1.22)	1.13 (1.01–1.26)	1.10 (0.96–1.26)	
Cough during nights	0.71 (0.61–0.82)	0.77 (0.65–0.90)	0.74 (0.52–1.06)	1.17 (0.93–1.47)	1.37 (1.05–1.80)	0.73 (0.59–0.91)	0.92 (0.77–1.09)	1.04 (0.85–1.26)	
Doctor- diagnosed asthma	0.82 (0.69–0.98)	0.93 (0.77–1.12)	0.77 (0.50–1.19)	1.91 (1.51–2.40)	1.85 (1.44–2.37)	1.05 (0.77–1.44)	1.51 (1.23–1.84)	1.59 (1.28–1.98)	
Rhinitis last 12 months	0.78 (0.69–0.88)	0.86 (0.75–0.99)	0.98 (0.71–1.34)	1.29 (1.07–1.56)	1.36 (1.09–1.71)	0.90 (0.75–1.08)	1.05 (0.91–1.21)	1.23 (1.04–1.45)	
Rhinitis on pet exposure	0.73 (0.59–0.89)	0.80 (0.64–1.00)	0.76 (0.41–1.39)	1.80 (1.39–2.33)	1.77 (1.36–2.32)	0.69 (0.44–1.09)	1.41 (1.11–1.78)	1.62 (1.26–2.07)	
Rhinitis on pollen exposure	0.56 (0.45–0.70)	0.63 (0.50–0.80)	0.85 (0.49–1.47)	1.06 (0.78–1.43)	0.91 (0.65–1.27)	0.81 (0.57–1.14)	0.86 (0.68–1.10)	1.01 (0.78–1.32)	
Doctor-diagnosed allergic rhinitis	0.73 (0.56–0.96)	0.85 (0.64–1.14)	1.20 (0.59–2.45)	1.27 (0.87–1.85)	1.46 (1.00–2.12)	1.03 (0.63–1.70)	1.29 (0.95–1.75)	1.26 (0.90–1.75)	
Eczema last 12 months	0.65 (0.59–0.72)	0.73 (0.66–0.81)	0.91 (0.72–1.14)	0.96 (0.81–1.13)	0.99 (0.81–1.21)	0.80 (0.70–0.91)	0.87 (0.78–0.97)	0.94 (0.82–1.08)	

\* Model I: Analysis adjusted for age, sex, ETS, allergic symptoms in family, breastfeeding and type of building.

† Model II: Analysis adjusted for age, sex, ETS, allergic symptoms in family, breastfeeding, type of building plus any avoidance behaviour.

‡ Model III: Analysis adjusted for age, sex, ETS, allergic symptoms in family, breastfeeding and type of building plus current pet-keeping.

§ Avoidance behaviour in families that avoid getting pets and/or have got rid of pets because of allergy in family.

Table 3. Associations between the number of types of furred pet at time of birth (cat, dog and/or hamster/rabbit) and symptoms among 10 851 children aged 1–6 years. Associations expressed as OR adjusted in four different models

Symptoms	OR (95 % CI)			
	Number of types of pet at time for birth*			
	0 (Ref.) <i>n</i> = 5415 56.6	1 <i>n</i> = 3173 33.1	2 <i>n</i> = 919 9.6	3 <i>n</i> = 64 0.7
Model I†				
Wheezing last 12 months	1.0	0.89 (0.79–1.00)	1.02 (0.84–1.22)	1.25 (0.68–2.30)
Doctor-diagnosed asthma	1.0	0.98 (0.80–1.19)	0.81 (0.57–1.15)	1.99 (0.78–5.08)
Rhinitis on pet exposure	1.0	0.82 (0.64–1.04)	0.69 (0.45–1.04)	1.52 (0.46–4.95)
Doctor-diagnosed allergic rhinitis	1.0	0.93 (0.68–1.26)	0.63 (0.35–1.16)	2.18 (0.52–9.21)
Model II‡				
Wheezing last 12 months	1.0	1.08 (0.96–1.22)	1.31 (1.09–1.58)	1.54 (0.83–2.8)
Doctor-diagnosed asthma	1.0	1.54 (1.24–1.91)	1.54 (1.06–2.32)	3.56 (1.36–9.34)
Rhinitis on pet exposure	1.0	1.35 (1.05–1.74)	1.47 (0.94–2.29)	3.04 (0.88–10.47)
Doctor-diagnosed allergic rhinitis	1.0	1.37 (0.99–1.90)	1.14 (0.61–2.11)	3.60 (0.83–15.61)
Model III§				
Wheezing last 12 months	1.0	1.08 (0.94–1.24)	1.29 (1.05–1.59)	1.60 (0.86–2.98)
Doctor-diagnosed asthma	1.0	1.61 (1.28–2.02)	1.62 (1.10–2.40)	4.18 (1.60–10.96)
Rhinitis on pet exposure	1.0	1.58 (1.22–2.04)	1.81 (1.14–2.88)	4.46 (1.32–15.13)
Doctor-diagnosed allergic rhinitis	1.0	1.31 (0.92–1.86)	1.02 (0.53–1.94)	3.73 (0.86–16.16)
Model IV¶	<i>n</i> = 2302	<i>n</i> = 1400	<i>n</i> = 424	<i>n</i> = 27
Wheezing last 12 months	1.0	0.91 (0.73–1.13)	1.15 (0.83–1.60)	1.84 (0.67–5.01)
Doctor-diagnosed asthma	1.0	1.48 (1.07–2.01)	1.17 (0.64–2.14)	6.45 (1.79–23.22)
Rhinitis on pet exposure	1.0	1.20 (0.85–1.70)	1.30 (0.69–2.43)	4.68 (1.02–21.54)
Doctor-diagnosed allergic rhinitis	1.0	0.88 (0.56–1.39)	0.86 (0.39–1.90)	5.45 (1.18–25.21)

\* Number of different types of pet: 0 = no cat or dog or hamster/rabbit at time for birth of the child; 1 = at least one of the three types; 2 = at least two of the three types of pet; 3 = all three types of pet.

† Model I: Analysis adjusted for age, sex, ETS, allergic symptoms in family, breastfeeding and type of building.

‡ Model II: Analysis adjusted for age, sex, ETS, allergic symptoms in family, breastfeeding, type of building plus any avoidance behaviour in family.

§ Model III: Analysis adjusted for age, sex, ETS, allergic symptoms in family, breastfeeding, type of building plus current pet-keeping.

¶ Model IV: Children aged 4–6 years. Analysis adjusted for age, sex, ETS, allergic symptoms in family, breastfeeding, type of building plus current pet-keeping.

selection bias. The results are supported by similar findings by Brunekreef et al. (1). Such a selection bias was also considered as an explanation for reported negative associations between pet-keeping and symptoms in the Nordic multidisciplinary review on pet-keeping and allergies (2).

Hesselmar et al. (3) reported in a study of 402 children that pet-keeping during the first year of life decreased the risk of asthma and sensitization to cat at the age of 12–13 years. In the analysis they excluded about one-fourth of the children whose parents had actively decided against pet-keeping during infancy because of allergy in the family. In a similar analysis of our data we also see a tendency towards a 'protective' effect of pet exposure (model I, Table 2). However, such an analysis means that only a selected group, which can better withstand exposure to pets, is analysed.

Roost et al. (4) included cross-sectional data from 16 countries, comprising 13 509 adults (20–44 years). Childhood exposure to cats was associated with a decrease in adult sensitization to cats, particularly among those with a family history of atopy. Svanes et al. (5) investigated 13 932 adults (20–44 years) – mainly the same population as in Ref. (4) – and showed that pet-keeping in childhood (mainly dog) was negatively associated with adult atopy (IgE). The effect remained after adjustment for parental and sibling allergy and adult pet ownership. In our data, adjustments for parental and sibling symptoms did not change the main results that pet-keeping is 'protective' against symptoms. However, after adjustments for current pet-keeping we found an increased risk of symptoms when exposed to pets at time of birth.

Platts-Mills et al. (6) showed that increasing current exposure to mite allergen increased the risk of sensitization to mites in children aged 12–13 years. On the other hand, for cat allergen, the highest exposure was associated with decreased sensitization to cats. In fact, they found a bell-shaped relationship between sensitization and cat-allergen exposure, meaning that a medium exposure to cat allergens was associated with an increased risk of sensitization, but that a low or high exposure was 'protective'. One possible explanation for such associations is that families affected by allergy avoid pets, as the authors point out. In order to adjust for the bias introduced by avoidance of pets, they looked at the prevalence of 'atopic children' in different cat allergen exposure groups and found that there was no difference between the groups. 'Atopy' – defined by positive Skin Prick Tests to mites, cockroach, cat or pollen – is maybe not a good indicator of an avoidance behaviour with regard to pets. It is reasonable to believe that people behave more on the basis of actual symptoms in the family than as a result of a sensitization of which they may not be aware. Families that 'know' that they are at risk of reacting avoid being exposed, but not other families.

Ownby et al. (7) showed in a cohort study on children that cat exposure during the first year of life (self-reported by parents at 1 year of age of the child) decreased the risk of sensitization for different allergens at the age of 6–7 years. In order to handle avoidance, the analyses were adjusted for potential confounding factors including current pet-keeping. They then found that exposure to two or more dogs or cats in the first year of life was associated with a reduced risk of sensitization. In a similar analysis but concerning symptoms, we found the opposite, namely a positive dose-response relationship between the number of different types of pet at time of birth and the risk of symptoms later in life (Table 3).

Most of the recently published studies on associations between pet-keeping and allergies have not handled fully the selection bias introduced by a possible avoidance behaviour towards pets. However, many have reported an 'avoidance' behaviour with regard to pets, due to allergy in the family, in a range of 8–25% (1, 3, 4, 8). Adjustment for such 'avoidance' has been made mainly by exclusion of sub-populations such as: people with avoidance behaviour, people with allergy in the family and people with symptoms in the presence of pets, thus ending in analyses that exclude the 'sensitive' population.

Interestingly, there is no report of a preventive effect (for sensitization or symptoms) from being exposed to high concentrations of allergens from, e.g. mites or cockroaches. Platts-Mills discusses whether this may be due to different routes of exposure. Another explanation is that avoidance behaviour is more easily induced towards more visible and known risks.

In conclusion, domestic pet exposure is common in Swedish families with children. Current pets are 'protective', but this may be due to the fact that people avoid exposing themselves or their child to something that they believe is a risk factor for allergies. Pet exposure at the time of birth is associated with asthma and rhinitis on pet exposure later in life for large groups of children. The distribution of pets in the population is largely explained by active avoidance of pets because of allergy. The level of knowledge regarding allergies in society is at the basis of this avoidance behaviour. The more that people are aware of the risks of having pets, the more they will adopt an avoidance behaviour, and the more 'protective' will pet-keeping be in analyses of epidemiological data, regardless of study design, if 'avoidance' has not been dealt with properly.

### Acknowledgments

The study was supported by Formas, Swedish Asthma and Allergy Association's Research Foundation, and the Swedish Foundation for Health Care Sciences and Allergy Research.

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