

The association of pet keeping at home with symptoms in airways, nose and skin among Bulgarian children

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The role of pet exposure in early childhood for allergy/ asthma later in life is still controversial. Recently it was shown that 'avoidance behaviour' is an important factor for the pet distribution in the population. The aim of the present work is to study the association between self-reported pet keeping at home and symptoms in airways, nose and skin among children 2–7 years of age, in a country where primary prevention strategies regarding allergies are not common. A cross-sectional survey on the association between allergy and asthma symptoms and home environmental factors was conducted in two towns in Bulgaria in spring 2004 (the ALLHOME-1 study). Data for 4479 out of 12982 children was obtained. 21.3% of the parents reported having pets at the time of the questionnaire, and 23.3% for pet keeping at index child's birth. Parents of 3.3% of the children got rid of some of the pets and 10.6% refrained from having pets, due in both cases to allergic illness in the family. Keeping dogs or cats at the time of the survey or during the child's first years was associated with most of the symptoms (aOR 1.1–2.2).

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The role of pet exposure in early childhood for allergy/asthma later in life is still controversial. A Nordic interdisciplinary review, NORDPET (1), concluded that pet exposure in infancy increases the risk for sensitization (RR 1.0–1.5) and to a lesser degree increases the risk of development of symptoms. Examples of health effects associated with both actual and early life pet exposure are asthma, allergic rhinitis and atopic eczema. Pet keeping as a risk factor for asthma and wheezing in children was also reported in the review by Apelberg et al. (2). However, in the study by Lau et al. (3) no relationship was found between early indoor pet allergen exposure and prevalence of asthma, wheeze and bronchial hyper-responsiveness. In a number of studies (4–6), an inverse relationship between early pet exposure and allergic diseases later in life has been found, suggesting a 'protective' effect of pet

keeping. Platts-Mills et al. (7) suggested that exposure to allergens (e.g. to cat allergens) can produce an immunoglobulin G (IgG) and IgG4 antibody response without sensitization or risk of asthma. This modified T-helper-2 cell response could be regarded as a form of tolerance. Such assumption may also explain the observation that animals can decrease the risk of asthma.

However, such inverse associations between current or early life pet ownership and symptoms could be due at least partly to avoidance behaviour in the families. People could avoid pets if there are family members who show symptoms when exposed. Brunekreef et al. (8) and Bornehag et al. (9) revealed 'avoidance behaviour' as an important factor for pet distribution in the population, thus modulating the role of pet exposure on allergies. They found that those who have pets are mainly those who can stand

them, i.e. a 'healthy pet keeping effect' (9). Recently Svanes et al. (10) reported selective avoidance observed for childhood cat keeping and adult cat acquisition. Such avoidance would produce an apparent protective effect of cats on childhood asthma.

To date, a limited number of studies regarding pet keeping in Bulgaria and its effect on children's health (11) have been performed. The existing low awareness in the Bulgarian society regarding risk factors for asthma and allergies could further make possible to estimate the 'true' exposure to pets.

The aim of the present work was to study the association between self-reported pet keeping at home (both at the time of the questionnaire and at birth) and symptoms in airways, nose and skin among children 2–7 yr of age, in a country where primary prevention strategies regarding allergies are not common.

Method

The current study is part of the ALLHOME-1 study, a cross-sectional survey on the association between symptoms in airways, nose and skin and home environmental factors, conducted in two towns in Bulgaria (Burgas and Sofia). A questionnaire was distributed by post to the parents of all 12,982 children at ages 2, 3, 5 and 7 yr in the two predefined areas on the basis of data obtained from the national data register. Data on symptoms for the index child and other family members as well as on demographic and home characteristics, including pet keeping, were collected as answers to 87 questions. Details of the study design and methods are described elsewhere (12).

The disease outcomes in the questionnaire were wheezing, rhinitis, eczema, cough at night, doctor-diagnosed asthma, allergic rhinitis and rhinitis on pet exposures. The questions were the same as those used in the ISAAC study (13) and the Swedish DBH-study (9).

Six questions on pet keeping were included in the survey. Data on pet keeping and type of pet at home, both during the child's first years and at the moment of the survey, were collected. Two questions regarding on possible avoidance behaviour were included: 'Did you get rid of some of the pets due to allergic illness in the family?' and 'Did you avoid having pets due to allergic illness in the family?'. One question on whether the child had any contact with pets outside the home (e.g. at friends, relatives, etc.) was further asked.

In the analyses, pets during the child's first years of life were defined as 'pets at birth' and pets at the time of the survey as 'current' pets. To

increase the reliability of the collected data, the number of current pets and pets at birth was calculated only if a specific type of pet was reported. Fourteen responses on current pets and 11 on pets at birth were excluded in this procedure. Pet keeping in both periods was regarded as 'ever' pet keeping, no reports of any pet keeping (either at birth or currently) as 'never', and reports for current pets but not at birth or vice versa as pet keeping 'any time' in child's life. Only case of families, who got rid of some of their pets or/and refrained from having pets due to allergic illness in the family were included in the analyses.

In total, data of 4479 children were gathered (4224 families) corresponding to a response rate of 34.5%. The pet keeping frequency was based on the data of all 4479 children rather than on the 4224 families.

Logistic regression models were used to determine the association between pet keeping and children's symptoms. In the multivariate analyses, adjustments were made at least for sex (boys vs. girls), age (≤ 3 vs. ≥ 5 yr), family allergic symptoms (Yes vs. No), parental smoking during pregnancy and/or first child's year (Yes vs. No), town (Burgas, Sofia). The independent variables and confounding factors were entered in a single step. A p-value of $< 5\%$ ($p < 0.05$) was accepted to be of significance. Statistical analyses were performed with SPSS for Windows, release 14.0 (SPSS Inc., Chicago, IL, USA).

The local ethical committee approved the study.

Results

One-fourth of the parents reported having pets at home either during the child's first year or at the time of the questionnaire study (Table 1). The most commonly reported current pet was a 'dog' (40.8%) followed by an 'aquarium fish' (27.0%), a 'cat' (26.8%), a 'bird' (18.1%) and a 'rodent' (13.1%). Half of the parents (58.1%) reported that the child had regular pet contact outside the home. No significant difference was observed for pet keeping in families with or without allergy, asthma or eczema. 21.5% of the families with any allergic members reported current pet keeping compared with 21.1% from families without such symptoms. The corresponding frequencies regarding pet keeping during the index child's first year were 23.8% vs. 23.0%.

Pet keeping was significantly more often reported by parents in Sofia (current: 24.7%, at birth: 27.1%) than in Burgas (current: 18.0%, at birth: 19.7%). Parents living in single-family

Table 1. Distribution of reported asthma/allergy symptoms among 4479 children, aged 2–8 yr divided into different groups depending on pet keeping during the child's first years and current as well as any avoidance behaviour

	Total	Current pets	Pet at child's birth	No current pet and no pet at child's birth	Current pet and no pet at child's birth	No current pet and pet at child's birth	Current pet and pet at child's birth	Got rid of some of the pets*	Refrained from having pets*
Children n (%)	4479 (100)	933 (21.3)	999 (23.3)	2927 (68.4)	345 (7.9)	407 (9.5)	579 (13.2)	146 (3.3)	463 (10.6)
Demographic characteristics									
Age ≤ 3 yr	52.9	18.9	23.0	72.4	4.2	8.0	14.4	2.6	9.3
Age ≥ 5 yr	47.1	24.0	23.6	63.8	12.0	11.2	11.8	4.0	12.0
Town: Sofia**	46.1	24.7	27.1	64.4	8.1	10.0	16.3	3.4	11.8
Town: Burgas**	53.9	18.0	19.7	72.2	7.6	9.1	10.2	3.2	9.6
Reported symptoms – last 12 months									
Wheezing	29.6	31.2	30.9	28.4	29.9	30.2	31.1	44.4	42.0
Rhinitis	28.0	27.3	26.3	27.8	27.8	25.8	26.8	46.6	45.3
Rhinitis on pet exposure	4.3	5.7	6.2	3.3	5.6	6.4	5.7	24.6	12.7
Eczema	12.5	13.8	14.0	11.9	12.4	13.4	14.3	24.6	21.2
Family's symptoms†	31.3	31.7	32.0	30.8	32.2	33.4	31.0	100	100
Reported doctor-diagnoses-ever									
Asthma	4.4	4.3	4.8	4.1	4.7	6.3	3.8	16.6	12.0
Allergic rhinitis	7.7	7.0	7.7	7.3	7.7	9.5	6.5	21.5	17.9

Percentages marked in bold show the significant difference ($p < 0.05$) between pairs in the stratified groups (age, town).

*Percentage given for children whose parents reported any avoidance and for asthma/allergy symptoms among the family members.

†Asthma, rhinitis and/or eczema among other family members than the index child (mother, father, siblings).

**Data stratified to town is based on 4445 responses.

houses reported more often ($p < 0.05$) current pets (24.5%) compared to those living in multi-family houses (20.8%). Pet keeping, both current and at birth, was associated significantly with the size of the residence [current: 19.2% ($< 75 \text{ m}^2$); 23.9% ($> 75 \text{ m}^2$); at birth: 21.8% ($< 75 \text{ m}^2$); 25.1% ($> 75 \text{ m}^2$)]. Parents of children aged ≤ 3 yr reported less often current pet keeping (18.9%) compared to those with children aged ≥ 5 yr, (24.0%, $p < 0.05$). Pet keeping was reported significantly more often by parents where current smoking occurred (current: 23.1%, at birth: 25.6%) compared to homes where no one was smoking (current: 16.6%, at birth: 17.1%). These factors were adjusted in the multivariate analyses.

In total, 68.4% of the parents reported never having pets at home, compared to 13.2% who had pets both at the time of the survey and at birth, and 18.4% who reported either having pets during the first year but not currently or vice versa. Among all combinations of pet keeping in time, children who ever had pets showed the lowest prevalence of asthma and/or rhinitis, diagnosed by a doctor, while those who never had pets at home had the lowest prevalence of wheezing, cough, rhinitis on pet exposure and eczema (Table 1). However, these differences were not significant. The highest prevalence of asthma and/or hay fever diagnosed by a doctor as well as allergy-like symptoms (rhinitis on pet exposure, eczema) and cough at night was

reported for children who had pets during the first years of their life but not at the time of the survey.

Parents of 3.3% of the children had 'got rid of' and 10.6% 'refrained' from having pets. Families who avoided pets at home reported significantly more for all asthma and allergic symptoms and diagnoses among their children compared to those who did not (Table 1).

Dogs and cats were the most commonly reported pets. After adjustment for potential confounders, current keeping of dog (aOR 1.36–2.14) was associated significantly with wheezing and rhinitis on pet exposure symptoms among index children. Similarly, current cat's keeping was associated with rhinitis on pet exposure, aOR 1.89 (1.10–3.23). Health data on the children having either dog or/and cat at home was further analysed and results are given in Table 2. Similar tendency was observed. Further adjustments for any avoidance behaviour strengthened these associations.

Keeping a furred pet (cat, dog and/or rodent) during the child's first years was associated with an increased risk of most of the symptoms and was a significant risk factor for rhinitis on pet exposure. The associations remained and became even stronger after adjusting for avoidance behaviour and current furred pet keeping (Table 3).

To investigate a potential selection bias between participating and non-participating

Table 2. Association between dog and/or cat kept at the residence during child's first years and currently and symptoms among 4479 children aged 2–8 yr

	Pet keeping at birth	Current pet keeping	
	Model I*	Model I*	Model II†
Reported symptoms – last 12 months			
Wheezing	1.13 (0.93–1.36)	1.16 (0.95–1.42)	1.26 (1.01–1.56)
Rhinitis	0.91 (0.75–1.11)	0.92 (0.75–1.13)	0.98 (0.79–1.21)
Rhinitis on pet exposure	1.81 (1.24–2.64)	1.93 (1.31–2.85)	2.20 (1.46–3.22)
Eczema	1.22 (0.99–1.50)	1.30 (1.04–1.63)	1.28 (1.01–1.61)
Reported doctor-diagnoses-ever			
Asthma	1.19 (0.80–1.77)	0.92 (0.59–1.45)	1.09 (0.69–1.72)
Allergic rhinitis	0.86 (0.61–1.20)	0.82 (0.57–1.19)	0.90 (0.62–1.31)

Associations expressed as OR (95% CI) adjusted for potential confounders.

*Adjustments made for sex (boys vs. girls), age (≤ 3 vs. ≥ 5 yr), family allergic symptoms (Yes vs. No), parental smoking during pregnancy and/or first child's year (Yes vs. No), town (Burgas, Sofia). Second category is taken as reference.

†Adjustments made for sex (boys vs. girls), age (≤ 3 vs. ≥ 5 yr), family allergic symptoms (Yes vs. No), parental smoking during pregnancy and/or first child's year (Yes vs. No), town (Burgas, Sofia), got rid of some of the pets only due to allergic illness in the family (Yes vs. No), refrained from having pets only due to allergic illness in the family (Yes vs. No). Second category is taken as reference.

Table 3. Association between furred pet keeping during child's first years and symptoms later in life among children in Bulgaria (ALLHOME-1) and Sweden (DBH)

	Adjusted OR					
	ALLHOME*			DBH*		
	Model I	Model II†	Model III‡	Model I	Model II†	Model III‡
n	4479	4479	4479	9895	9747	9895
Reported symptoms – last 12 months						
Wheezing	1.06 (0.88–1.27)	1.10 (0.91–1.34)	1.00 (0.79–1.26)	0.91 (0.82–1.01)	1.13 (1.01–1.26)	1.10 (0.96–1.26)
Rhinitis	0.88 (0.73–1.06)	0.86 (0.71–1.05)	0.82 (0.64–1.03)	0.86 (0.75–0.99)	1.05 (0.91–1.21)	1.23 (1.04–1.45)
Eczema	1.17 (0.92–1.49)	1.16 (0.90–1.49)	1.05 (0.78–1.43)	0.73 (0.66–0.81)	0.87 (0.78–0.97)	0.94 (0.82–1.08)
Rhinitis on pet exposure	1.65 (1.13–2.40)	1.61 (1.08–2.40)	1.15 (0.71–1.87)	0.80 (0.64–1.00)	1.41 (1.11–1.78)	1.62 (1.26–2.07)
Reported doctor-diagnoses-ever						
Asthma	1.17 (0.79–1.73)	1.29 (0.87–1.93)	1.29 (0.82–2.05)	0.93 (0.77–1.12)	1.51 (1.23–1.84)	1.59 (1.28–1.98)
Allergic rhinitis	0.86 (0.62–1.19)	0.91 (0.64–1.28)	0.93 (0.62–1.38)	0.85 (0.64–1.14)	1.29 (0.95–1.75)	1.26 (0.90–1.75)

Associations expressed as OR (95% CI) adjusted for potential confounders.

*Analysis adjusted for sex, age, smoking, type of dwelling, symptoms in the family, breastfeeding.

†Analysis adjusted for all confounders in Model Ia plus any avoidance behaviour.

‡Analysis adjusted for all confounders in Model Ia plus current pet-keeping.

children, a non-respondent analysis was made among parents of 240 (78 in Burgas and 162 in Sofia) children who did not participate in the ALLHOME-1 study. Randomly selected non-responding parents from the selected regions were contacted by phone, and were asked to answer all questions used in the questionnaire.

Significantly more children aged younger than 3 yr took part in the ALLHOME-1 study (in Sofia) compared to children in the non-respondent study. Children who participated in the ALLHOME-1 study had a higher prevalence of current eczema and lower prevalence of rhinitis on pollen exposure (in Burgas). No significant difference was observed for the rest of the studied symptoms, e.g. wheezing and rhinitis – last 12 months; doctor-diagnosed asthma and allergic rhinitis among children. Parental decision to join the study was independent of keeping pets at

home (current or/and at birth) as well as the parental decision to get rid of some of their pets. Significantly more often parents who participated in the ALLHOME-1 study (in Burgas) refrained from having pets due to allergic illness in the family compared to those who did not (9.6% vs. 2.6%).

Discussion

A relatively low response rate (34.5%) was obtained in the current survey. Thus, the observed distribution of pet keeping and prevalence of health symptoms derived from the study should be viewed with caution. Generally, the results obtained in the ALLHOME-1 study regarding most of the health and indoor environmental outcomes are in accordance with data obtained in recently performed studies in Bulgaria with high

response rates (ca. 90%) (11). Adjustments for potential confounders and the agreement in the associations obtained when compared to other studies, limit the risk of serious selection bias. A detailed discussion on the low response rate in the ALLHOME-1 study is presented elsewhere (12).

Pet keeping was reported less often by families in the current survey than in the earlier CESAR study made in Bulgaria (11), but similar to other studies across Europe (5, 6, 9). The target group in the CESAR study by Antova and Nikiforov (11) was children aged 7–11 yr. The current survey focused on pre-school children (2–7 yr), as in studies made by Nafstad et al. (5), Zirngibl et al. (6) and Bornehag et al. (9). The ALLHOME-1 study showed further that the age of the children was positively associated with pet possession: 28.4% of the families in Sofia reported currently keeping furred/feathered pets ('dog', 'cat', 'rodent' and/or 'bird') when their children were 7 yr of age, compared to 19.2% for children 2 yr of age.

The ALLHOME-1 study documented a higher percentage of current pets in families living in single-family houses compared to those living in multi-family houses ($p < 0.05$). A similar tendency was observed in the CESAR study, where 51.2% of the families in Sofia-centre (mainly single-family houses) reported pet keeping compared to 47.9% in a Sofia suburb (Ljulin, a district with blocks of flats). Besides the lower frequency for pet keeping obtained in the current survey, both studies revealed a difference between the prevalence of pets in Sofia (the capital) and in smaller towns.

No significant difference in the percentage of pet keeping in families with and without allergy/asthma problems was observed. It can be a result of a low society awareness regarding asthma and allergy prevention. 10.6% of the parents reported refraining from having pets and 3.3% got rid of pets because of allergic illness in the. Reported percentages for such avoidance behaviour were, e.g. two times lower compared to those obtained in Sweden (9), a country where public awareness regarding keeping of pets exists (14). Recently Erwin et al. (15) in a review on the effect of pet keeping on the development of asthma concluded that 'the evidence suggests' that family choice for pet keeping 'may be an element of the phenomenon in some northern European countries'. The current study did not find that pet keeping was 'protective' against allergy and asthma, in contrast to other cross-sectional or cohort investigations, made in Western Europe and USA (4–6, 8, 9, 16–22). Even though the mechanism of such 'protection' is still not clarified public awareness

and consequent pet avoidance should not be neglected in the analyses (23).

Families who refrained from taking pets or got rid of some of the pets at birth at home reported significantly more often all asthma and allergic symptoms and diagnoses among their children compared to those who did not. Symptoms among children or family members could be a driving force to avoid pet possession at home. This was further emphasized by number of studies [e.g. Custovic et al. (24), Yamasaki et al. (25)] in which was shown that environmental manipulation (reduction of pet exposure) reduces some respiratory symptoms in high-risk patients. Bacharier and Strunk (26) concluded that paediatricians must be clear that the presence of a pet in the house of a child who is allergic to pets and has asthma causes a worsening of the disease. Furthermore, Remes et al. (27) reported that dog exposure in early life might prevent the development of asthma-like symptoms, at least in low-risk children with no family history of asthma.

The current survey revealed similar associations between exposure to current pets and health effects as those found in the CESAR study. Antova and Nikiforov (11) reported a positive association between keeping furred/feathered pets in Bulgarian homes and wheezing and rhinitis (aOR 1.06–1.11) among children (7–11 yr) and a significant association particularly between pets and eczema-ever with aOR 1.3 (1.0–1.7). Furthermore, the positive association between pets at birth and health outcomes in the ALLHOME-1 study supports the findings provided in the NORDPET review (1) where early pet exposure increases the risk of allergic diseases.

The ALLHOME-1 study is a twin project to the DBH study started in 2000 in Sweden (9). In that study Bornehag et al. (9) defined 'furred pet keeping' as keeping dogs, cats and/or rodents in the child's residence. Authors found negative associations between furred pet keeping during the child's first years of life and health outcomes (Table 3). However, after adjustments for any avoidance behaviour and current furred pet keeping, the negative association was no longer observed and in contrast, furred pet keeping was a risk factor for most of the symptoms and diagnoses. In the ALLHOME-1 study, adjustments for 'getting rid of some of the pets', 'refrain from pet keeping' or 'current pet keeping' did not change substantially the associations between pet keeping during the child's first years and the symptoms studied. The expressed avoidance behaviour is in part driven by the degree of knowledge among the general public regarding

pet keeping and the risk for asthma/allergy. Very little attention is paid in the Bulgarian society to asthma and allergy risk factors such as pet keeping and this can explain partly the results obtained. Most of the studies reporting a 'protective pet-keeping effect' were made in countries where public awareness regarding keeping of pets/allergy exists.

Conclusion

One-fourth of the parents in the ALLHOME-1 study reported on either current pet keeping or pets at child's birth. The study did not identify pet keeping as being 'protective' against allergy and asthma, in contrast to other cross-sectional or cohort investigations, made in northern Europe in the last decade. Current results indicate that current pet keeping and pets at home at child's birth is a risk factor for the health outcomes studied among children. The effect of public awareness and consequent pet avoidance on pet distribution should be studied in future studies.

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