



Original Article

Association between pet-keeping and asthma in school children

Biljana Medjo,^{1,7} Marina Atanaskovic-Markovic,^{2,7} Dimitrije Nikolic,^{3,7} Brankica Spasojevic-Dimitrijeva,^{4,7} Petar Ivanovski^{5,7} and Slobodanka Djukic^{6,7}

¹Pediatric Intensive Care Unit, Departments of ²Pulmonology and Allergology, ³Neurology and ⁴Nephrology, ⁵Pediatric Clinic, University Children's Hospital, ⁶Institute of Microbiology and Immunology and ⁷Medical Faculty, University of Belgrade, Belgrade, Serbia

Abstract **Background:** The role of pet exposure in childhood asthma and allergy is still controversial. The aim of this study was to investigate the association between pet-keeping during different periods of childhood and asthma and sensitization in school children.

Methods: One hundred and forty-nine children aged between 7 and 14 years were enrolled in this study. Seventy-four children had current physician-diagnosed asthma, while 75 children did not have asthma. Pet-keeping was investigated by questionnaire. Allergic sensitization to pet allergen was assessed on skin prick tests and specific serum IgE concentration. Logistic regression analysis was performed, taking into account potential confounders.

Results: Early, past and current pet-keeping was not significantly associated with asthma. Neither owning a cat nor dog during childhood was associated with asthma. Early pet-keeping, however, was significantly associated with sensitization to pet allergens (adjusted odds ratio [aOR], 24.11; 95% confidence interval [CI]: 3.28–177.27). Further analysis showed that only early cat-keeping was significantly associated with sensitization to cat allergen (aOR, 51.59; 95%CI: 2.28–1167.07). Keeping a cat or a dog after the first year of life was not associated with sensitization to those allergens.

Conclusions: Keeping a cat or a dog does not increase risk for asthma. Keeping a cat in the first year of life, however, increases risk of sensitization to cat allergen. Considering that this is a relatively small study, larger, prospective, birth cohort studies are required in Serbia to accurately assess the relationship between pet-keeping, asthma and sensitization.

Key words asthma, child, hypersensitivity, pets, sensitization.

The association between exposure to pets early in life and subsequent development of sensitization and asthma remains controversial. Some studies have found a higher prevalence of allergic sensitization and respiratory illness in children with a cat or dog at home.^{1–3} Ahlborn *et al.* in their review concluded that pet exposure in infancy increases the risk of developing sensitization and allergic diseases.⁴ Pet-keeping as a risk factor for asthma and wheezing was also reported in the review by Apfelberg *et al.*⁵ Other studies, however, did not find this association between pet exposure and subsequent respiratory symptoms, asthma and sensitization, or they found an inverse relationship between pet exposure and allergic disease and/or sensitization, suggesting a protective effect of pet-keeping.^{6–9} Furthermore, it was observed that children living on a farm with animals have fewer allergic disease compared with children living in non-farming families or in cities.¹⁰ There are no data or studies regarding pet-keeping and its effect on children's health in Serbia at all. The aim of this study was to investigate the association between

early, past and current pet-keeping and sensitization, as well as the association between pet-keeping and asthma among children 7–14 years of age.

Methods

One hundred and forty-nine children aged between 7 and 14 years were enrolled in this study.

Patients were categorized into two groups. The asthma group included 74 children with current physician-diagnosed asthma enrolled from the outpatient clinic of Department of Pulmonology and Allergology of University Children's Hospital, Belgrade, Serbia. Asthma was diagnosed according to Global Initiative for Asthma (GINA) guidelines.¹¹ The control group consisted of 75 children without asthma recruited from other outpatient clinics of the same hospital who were reviewed by the respiratory physicians as well. This study was approved by the Ethics Committee of University Children's Hospital in Belgrade. Patients were enrolled in the study after written informed consent had been obtained from the parents or guardians.

Parents of all children were asked to complete a respiratory questionnaire (International Study of Asthma and Allergies in Childhood; ISAAC).¹² Questions about time of pet-keeping, type, and number of pets were included in the survey. Pet-keeping was classified into three categories: early pet-keeping, keeping a pet

Correspondence: Biljana Medjo, MD, MSc, University Children's Hospital, Medical Faculty, University of Belgrade, Tirsova 10, Belgrade 11 000, Serbia. Email: medjo.biljana@gmail.com

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in the household during the first year of the child's life; past pet-keeping, having a pet after the first year of life until the age of 7 years; and current pet-keeping, keeping a pet at the time of the survey. From the questionnaire, we also extracted information on potential confounders such as age, gender, parental history of allergy or asthma, maternal smoking during pregnancy and/or the child's first year, and avoidance of pets due to allergy or asthma in the family (avoidance behavior).

All children included in the study were tested with skin prick tests (SPT) using cat and dog allergen. Standardized allergen extracts and controls (negative controls and histamine as a positive control) were provided by Torlak Institute (Belgrade, Serbia). The test was performed on the volar side of the forearm using lancets. SPT was considered positive for particular allergen if the mean wheal diameter was ≥ 3 mm after 15 min.¹³

Specific serum immunoglobulin E (IgE) concentration was measured on fluoroenzyme-immunometric assay using the Pharmacia UNICAP system (Pharmacia Uppsala, Sweden). Allergen-specific IgE ≥ 0.35 kUA/L was considered as a positive test result. Sensitization was defined as having a positive SPT and IgE test to specific allergen.

Statistical analysis

Associations between exposure variables and sensitization and asthma was analyzed using cross-tabulations and calculation of simple odd ratio. Multivariate analysis, adjusting for age, gender, parental history of allergy or asthma, maternal smoking during pregnancy and/or child's first year, avoidance behavior, other periods of pet-keeping and other types of pets were conducted with logistic regression. $P < 0.05$ was considered as statistically significant. Statistical analysis was performed with SPSS version 10.0 (SPSS, Chicago, IL, USA).

Results

Subject demographic characteristics according to presence of asthma are given in Table 1. Study groups were similar in age, gender and maternal smoking during pregnancy and/or the

child's first year. Moreover, there was no significant difference in reported avoidance behavior (i.e. 'Avoid getting pets due to allergy or asthma in the family') between children with and without asthma. Children in the asthma group, however, more often had a parental history of allergy or asthma. As shown in Table 1, more than half of the children in both groups owned a pet during their childhood. Dogs and cats were the most commonly reported pets in the asthma group as well as in the control group.

Furthermore, when we analyzed all 149 patients regarding pet ownership, we found that 54.3% of children had a pet during their childhood, 25.7% of them in the first year of life. Girls were more often pet owners than boys (61.0% vs 48.9%, respectively), but the difference was not statistically significant ($P = 0.147$). Moreover, we observed that 36.8% of children with a parental history of allergy or asthma owned a pet, while 56.2% of children without a parental history of those diseases owned a pet ($P = 0.115$). We did not find a difference in pet ownership between these two groups, although the proportions were suggestive of families with allergy or asthma avoiding pet ownership. The corresponding frequencies regarding pet-keeping during the child's first year, however, were 21.1% vs 23.8%, therefore no significant difference was observed for pet-keeping during the child's first year in families with or without allergy or asthma ($P = 0.891$). We noticed that children whose mother had been smoking during pregnancy and/or their first year of life significantly more often owned a pet (70.4% vs 44.2%; $P = 0.002$). These factors were adjusted in multivariate analysis.

Crude and adjusted associations between pet-keeping at different life periods and asthma are listed in Table 2. Early, past and current pet-keeping was not significantly associated with asthma (odds ratio [OR], 0.94; 95% confidence interval [CI]: 0.44–2.01; OR, 1.083; 95%CI: 0.57–2.06 and OR, 0.866; 95%CI: 0.45–1.66, respectively). Health data on the children owning either a cat or/and dog were further analyzed and the same tendency was observed. Neither keeping a cat nor a dog during childhood was associated with asthma. All estimated OR, those for pets and those for cats and dogs too, did not change after adjusting for possible confounders such as age, gender, parental history of allergy or asthma and maternal smoking during pregnancy and/or the child's first year (Table 2, model 1). No substantial changes were found when models were further adjusted for avoidance behavior (Table 2, model 2), other periods of pet-keeping (Table 2, model 3) and other types of pets (Table 2, model 4) as well.

As shown in Table 3, early pet-keeping was associated significantly with sensitization to pet allergens (OR, 16.59; 95%CI: 3.32–82.63). This association remained after adjusting for potential confounders such as age, gender, parental history of allergy or asthma and maternal smoking during pregnancy and/or the child's first year (OR, 17.70; 95%CI: 3.37–93.10) and also when the models were further adjusted for avoidance behavior (OR, 16.08; 95%CI: 3.04–84.93) and past and current pet-keeping (OR, 24.11; 95%CI: 3.28–177.27). There was no significant association between past and current pet-keeping and sensitization. When we separately analyzed data regarding owning either a cat or/and dog, we noticed that early, past and current cat-keeping

Table 1 Subject demographic characteristics vs presence of asthma

	Asthma group	Control group	<i>P</i> -value
Age (years), mean $\pm$ SD	10.7 $\pm$ 2.5	10.3 $\pm$ 2.2	0.271
Sex			
Male (%)	60.8	60.0	0.919
Female (%)	39.2	40.0	
Parental history of allergy or asthma (%)	21.6	4	0.001
Maternal smoking during pregnancy and/or the child's first year (%)	35.1	37.3	0.780
Avoidance behavior (%)	9.46	6.66	0.532
Pet-keeping (%)	55.4	52.0	0.677
Type of pet (%)			
Dog	20.3	22.7	0.686
Cat	10.8	13.3	
Dog and cat	14.8	12.0	
Other pets	9.5	4.0	

Table 2 Associations between pet-keeping at different life periods and asthma

	Crude OR (95%CI)	OR (95%CI)			
		Adjusted OR (95%CI)			
		Model 1	Model 2	Model 3	Model 4
Pet-keeping					
Early	0.94 (0.44–2.01)	0.95 (0.42–2.13)	0.87 (0.38–1.20)	0.89 (0.35–2.24)	
Past	1.08 (0.57–2.06)	1.11 (0.56–2.23)	0.97 (0.47–2.01)	1.26 (0.43–3.69)	
Current	0.87 (0.45–1.66)	0.94 (0.46–1.90)	0.85 (0.41–1.74)	0.75 (0.26–2.15)	
Cat-keeping					
Early	1.11 (0.42–2.91)	0.86 (0.31–2.40)	0.89 (0.32–2.49)	0.77 (0.22–2.67)	0.71 (0.20–2.56) [†]
Past	1.07 (0.48–2.35)	0.95 (0.41–2.19)	1.01 (0.43–2.36)	0.67 (0.16–2.72)	0.70 (0.17–2.87) [†]
Current	1.47 (0.60–3.56)	1.28 (0.50–3.25)	1.37 (0.53–3.50)	2.14 (0.48–9.37)	2.02 (0.46–9.01) [†]
Dog-keeping					
Early	0.98 (0.40–2.43)	0.99 (0.38–2.55)	1.08 (0.41–2.87)	0.77 (0.23–2.57)	0.81 (0.24–2.75) [‡]
Past	1.20 (0.58–2.47)	1.25 (0.58–2.70)	1.42 (0.65–3.13)	1.68 (0.38–7.33)	1.61 (0.36–7.13) [‡]
Current	1.19 (0.59–2.43)	1.18 (0.55–2.50)	1.30 (0.60–2.81)	0.94 (0.25–3.61)	0.99 (0.25–3.85) [‡]

Model 1, adjusted for age, gender, parental history of allergy or asthma and maternal smoking during pregnancy and/or the child's first year. Model 2, adjusted for age, gender, parental history of allergy or asthma, maternal smoking during pregnancy and/or the child's first year and avoidance behavior. Model 3, adjusted for age, gender, parental history of allergy or asthma, maternal smoking during pregnancy and/or the child's first year, avoidance behavior and other periods of pet-keeping. Model 4, [†]adjusted for age, gender, parental history of allergy or asthma, maternal smoking during pregnancy and/or the child's first year, avoidance behavior, other periods of pet-keeping and dog-keeping, or [‡]adjusted for age, gender, parental history of allergy or asthma, maternal smoking during pregnancy and/or the child's first year, avoidance behavior, other periods of pet-keeping and cat-keeping. CI, confidence interval; OR, odds ratio.

was significantly associated with sensitization to cat allergen (OR, 59.54; 95%CI: 6.65–533.31; OR, 22.5; 95%CI: 2.52–200.78 and OR, 5.8; 95%CI: 1.10–30.74, respectively), but after adjusting for potential confounders only the relationship between early cat-keeping and sensitization remained significant (OR, 51.59; 95%CI: 2.28–1167.07). Regarding dog ownership, we did not find a significant association between keeping a dog in the

first year of life or in other periods of childhood and sensitization to dog allergen.

Discussion

In this study we assessed the association between pet-keeping during different periods of childhood and asthma and sensitization in children aged between 7 and 14 years. We found that early,

Table 3 Associations between pet-keeping at different life periods and sensitization

	Crude OR (95%CI)	OR (95%CI)			
		Adjusted OR (95%CI)			
		Model 1	Model 2	Model 3	Model 4
Pet-keeping					
Early	16.59 (3.32–82.63)*	17.70 (3.37–93.10)*	16.08 (3.04–84.93)*	24.11 (3.28–177.27)*	
Past	4.55 (0.93–22.22)	4.91 (0.97–24.77)	4.23 (0.83–21.47)	4.75 (0.49–45.81)	
Current	1.48 (0.41–5.36)	1.47 (0.39–5.54)	1.30 (0.34–4.89)	0.80 (0.17–0.94)	
Cat-keeping					
Early	59.54 (6.65–533.3)*	50.07 (5.17–488.97)*	47.67 (4.09–463.33)*	55.47 (3.17–970.79)*	51.59 (2.28–1167.07) ^{†*}
Past	22.5 (2.52–200.78)*	17.99 (1.94–167.29)*	17.25 (1.86–160.04)*	3.12 (0.94–103.75)	2.88 (0.84–98.13) [†]
Current	5.8 (1.10–30.74)*	4.16 (0.74–23.15)	4.02 (0.723–22.30)	3.90 (0.65–23.50)	3.83 (0.61–23.79) [†]
Dog-keeping					
Early	6.25 (0.83–46.93)	5.18 (0.75–44.98)	4.93 (0.62–38.98)	1.75 (0.13–23.37)	1.74 (0.125–24.26) [‡]
Past	8.45 (0.85–83.69)	8.80 (0.87–89.51)	7.30 (0.712–74.76)	15.40 (0.45–519.68)	15.44 (0.44–540.27) [‡]
Current	2.54 (0.346–18.61)	2.87 (0.37–22.53)	2.41 (0.31–18.75)	2.53 (0.13–4.86)	1.49 (0.13–17.00) [‡]

* $P < 0.05$. Model 1, adjusted for age, gender, parental history of allergy or asthma and maternal smoking during pregnancy and/or the child's first year. Model 2, adjusted for age, gender, parental history of allergy or asthma, maternal smoking during pregnancy and/or the child's first year and avoidance behavior. Model 3, adjusted for age, gender, parental history of allergy or asthma, maternal smoking during pregnancy and/or the child's first year, avoidance behavior and other periods of pet-keeping. Model 4, [†]adjusted for age, gender, parental history of allergy or asthma, maternal smoking during pregnancy and/or the child's first year, avoidance behavior, other periods of pet-keeping and dog-keeping, or [‡]adjusted for age, gender, parental history of allergy or asthma, maternal smoking during pregnancy and/or the child's first year, avoidance behavior, other periods of pet-keeping and cat-keeping. CI, confidence interval; OR, odds ratio.

past and current pet (cat or dog)-keeping was not associated with asthma. In contrast, keeping a cat in the first year of life was significantly associated with sensitization to cat allergen. We did not find any significant relationships regarding dog ownership and sensitization to dog allergen.

The present result is in accordance with some previously published studies.^{14–16} Studying school children, Anyo *et al.* observed that early and current pet ownership was not associated with asthma, although past pet-keeping was.¹⁴ In a birth cohort study Wahn *et al.* reported a positive association between cat allergen exposure and sensitization in the first 3 years of life.¹⁵ In the same cohort Lau *et al.* found no relation between early cat exposure and the prevalence of asthma, wheezing and hyper-responsiveness at the age of 7 years.¹⁶ A large Italian cross-sectional study that involved 20 016 children, showed that cat exposure in the first year of life was significantly associated with wheezing and asthma at the age of 7, while no significant relationship was found between early dog exposure and asthma at the age of 7.¹⁷

Several recent studies, however, of which some were prospective, reported an inverse relationship between pet exposure and allergy disease and/or sensitization, suggesting a protective effect of pet-keeping and pet exposure.^{6–9,18} All these studies suggesting a protective effect of pet-keeping and pet allergen exposure come from areas with a high proportion of pet owners.^{7,8,19,20} Pet allergens are passively transferred from the home of pet owners to homes without pets and public places,²¹ and the passive exposure is likely to be higher in areas where pet ownership is more common. In such areas, it is likely that passive exposure is sufficient for non-pet owners to become sensitized. Therefore, it seems that the effect of pet ownership may differ between different areas and is related to the prevalence of pet ownership and community exposure to pet allergens.²² In contrast, in the present study, we did not find that pet-keeping was protective against asthma and allergy sensitization, although the number of pet owners in the present sample was high (54.3%). This might not correspond, however, to the real prevalence of pet-keeping in Serbia. Unfortunately, there are no exact data regarding the frequency of pet-keeping in Serbia.

This protective effect of family pets on allergic disease might partly be attributed to the avoidance behavior.²³ People might not have pets if there are family members with asthma or allergy. In the present study we did not find a significant difference in the overall proportion of families who had pets in the groups with and without asthma and allergy problems, although the proportions were suggestive of families with allergy or asthma avoiding pet ownership. But there was no significant difference in pet-keeping during the child's first year in families with or without allergy or asthma. Moreover, only 8.0% of parents reported avoidance behavior in the present study, lower compared to other studies.² Also, adjustment in the analysis for this confounder did not change the results.

Also, the effect of pet ownership might also reflect the influence of additional concurrent environmental exposures.

The present study had some limitations. One of them was the small sample size. The study design also included retrospective

collection of information through questionnaire, without the possibility for direct validation of questions about pet-keeping. The present results might be limited due to the fact that we did not measure pet allergen concentration at the children's homes in order to estimate allergen exposure. Moreover, the results might be affected by the fact that we did not take into account data regarding children's past history of asthma, considering that most of them were reviewed by the respiratory physician for the first time at inclusion in the study. Furthermore, the enrollment of asthmatic children only from a hospital rather than a community setting may mean that they had asthma that was relatively more severe than in community based asthmatic children, which may limit generalization of the results. Additionally, the inclusion of non-asthmatic (healthy) children from a hospital, not from the general population may also influence the results.

In conclusion, keeping a cat or a dog does not increase risk for asthma, but keeping a cat in the first year of a child's life increases the risk of sensitization to cat allergen. In contrast, no significant associations were found between owning a cat after the first year of life or keeping a dog and sensitization. Recognizing the limitations of this study due to the small number of cases and the retrospective nature, larger, prospective, birth cohort studies are required in Serbia to accurately assess the frequency of pet-keeping and the relationship between pet-keeping, asthma and sensitization.

References

- Burr M, Anderson H, Austin J *et al.* Respiratory symptoms and home environment in children: A national survey. *Thorax* 1999; **54**: 27–32.
- Bornehag CG, Sundell J, Hagerhed L, Janson S. Pet-keeping in early childhood and airway, nose and skin symptoms later in life. *Allergy* 2003; **58**: 939–44.
- Melen E, Wickman M, Nordvall SL, van Hage-Hamsten M, Lindfors A. Influence of early and current environmental exposure factors on sensitization and outcome of asthma in pre-school children. *Allergy* 2001; **56**: 646–52.
- Ahlbom A, Backman A, Bakke J *et al.* NORDPET: Pets indoors – a risk factor for or protection against sensitization/allergy. *Indoor Air* 1998; **8**: 219–35.
- Apelberg BJ, Aoki Y, Jaakkola JJ. Systematic review: Exposure to pets and risk of asthma and asthma-like symptoms. *J. Allergy Clin. Immunol.* 2001; **107**: 455–60.
- Litonjua AA, Milton DK, Celedon JC, Ryan L, Weiss ST, Gold DR. A longitudinal analysis of wheezing in young children: The independent effects of early life exposure to house dust endotoxin, allergens, and pets. *J. Allergy Clin. Immunol.* 2002; **110**: 736–42.
- Remes ST, Castro-Rodriguez JA, Holberg CJ, Martinez FD, Wright AL. Dog exposure in infancy decreases the subsequent risk of frequent wheeze but not of atopy. *J. Allergy Clin. Immunol.* 2001; **108**: 509–15.
- Perzanowski MS, Ronmark E, Platts-Mills TA, Lundback B. Effect of cat and dog ownership on sensitization and development of asthma among preteenage children. *Am. J. Respir. Crit. Care Med.* 2002; **166**: 696–702.
- Ownby DR, Johnson CC, Peterson EL. Exposure to dogs and cats in the first year of life and risk of allergic sensitization at 6 to 7 years of age. *JAMA* 2002; **288**: 963–72.
- Lewis SA. Animals and allergy. *Clin. Exp. Allergy* 2000; **30**: 153–7.

- 11 Global Strategy for Asthma Management and Prevention. *Global Initiative for Asthma (GINA) 2009*. [Cited 10 December 2009.] Available from URL: <http://www.ginasthma.org>
- 12 Asher MI, Keil U, Anderson HR *et al*. International Study of Asthma and Allergies in Childhood (ISAAC): Rationale and methods. *Eur. Respir. J.* 1995; **8**: 483–91.
- 13 Sub-Committee on skin Tests of the European Academy of Allergology and Clinical Immunology. Skin test used in type I allergy testing. Position paper. *Allergy* 1989; **44** (Suppl. 10): 1–59.
- 14 Anyo G, Brunekreef B, de Meer G, Aarts F, Janssen NA, van Vliet P. Early, current and past pet ownership: Associations with sensitization, bronchial responsiveness and allergic symptoms in school children. *Clin. Exp. Allergy* 2002; **32**: 361–6.
- 15 Wahn U, Lau S, Bergmann R, Kulig M, Forster J. Indoor allergen exposure is a risk factor for sensitization during the first three years of life. *J. Allergy Clin. Immunol.* 1997; **99**: 763–9.
- 16 Lau S, Illi S, Sommerfeld C, Bergmann R. Early exposure to house-dust mite and cat allergens and development of childhood asthma: A cohort study. *Lancet* 2000; **356**: 1392–7.
- 17 Lombardi E, Simoni M, La Grutta S *et al*. Effects of pet exposure in the first year of life on respiratory and allergic symptoms in 7-year-old children. The SIDRIA-2 study. *Pediatr. Allergy Immunol.* 2010; **21**: 268–76.
- 18 Nafstad P, Magnus P, Gaarder PI, Jaakkola JJ. Exposure to pets and atopy-related diseases in the first 4 years of life. *Allergy* 2001; **56**: 307–12.
- 19 Custovic A, Hallam CL, Simpson BM, Craven M, Simpson A, Woodcock A. Decreased prevalence of sensitization to cats with high exposure to cat allergen. *J. Allergy Clin. Immunol.* 2001; **108**: 537–9.
- 20 Platts-Mills T, Vaughan J, Squillace S, Woodfolk J, Sporik R. Sensitization, asthma, and a modified Th2 response in children exposed to cat allergen: A population-based cross-sectional study. *Lancet* 2001; **357**: 752–6.
- 21 Custovic A, Green R, Fletcher A *et al*. Aerodynamic properties of major dog allergen Can f 1: Distribution in homes, concentration and particle size of allergen in the air. *Am. J. Respir. Crit. Care Med.* 1997; **155**: 94–8.
- 22 Svanes C, Heinrich J, Jarvis D *et al*. Pet-keeping in childhood and adult asthma and hay fever: European Community Respiratory Health Survey. *J. Allergy Clin. Immunol.* 2003; **112**: 289–300.
- 23 Svanes C, Zock JP, Anto J *et al*. Do asthma and allergy influence subsequent pet keeping? An analysis of childhood and adulthood. *J. Allergy Clin. Immunol.* 2006; **118**: 691–8.