Respiratory Tract Illnesses During the First Year of Life: Effect of Dog and Cat Contacts

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KEY WORDS
cat, dog, pets, respiratory infections

ABBREVIATIONS
aOR—adjusted odds ratio
CI—95% confidence interval
GEE—generalized estimating equations

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WHAT'S KNOWN ON THIS SUBJECT: Respiratory infectious symptoms are common during the first year of life. Day care attendance, older siblings, and lack of breastfeeding have been considered as possible factors influencing early respiratory tract infections.

WHAT THIS STUDY ADDS: Children with early dog contacts seem to have fewer infectious respiratory symptoms and diseases, especially otitis, during the first year of life.

abstract

FREE

OBJECTIVES: To investigate the effect of dog and cat contacts on the frequency of respiratory symptoms and infections during the first year of life.

METHODS: In this birth cohort study, 397 children were followed up from pregnancy onward, and the frequency of respiratory symptoms and infections together with information about dog and cat contacts during the first year of life were reported by using weekly diaries and a questionnaire at the age of 1 year. All the children were born in eastern or middle Finland between September 2002 and May 2005.

RESULTS: In multivariate analysis, children having dogs at home were healthier (ie, had fewer respiratory tract symptoms or infections) than children with no dog contacts (adjusted odds ratio, [aOR]: 1.31; 95% confidence interval [CI]: 1.13–1.52). Furthermore, children having dog contacts at home had less frequent otitis (aOR: 0.56; 95% CI: 0.38–0.81) and tended to need fewer courses of antibiotics (aOR: 0.71; 95% CI: 0.52–0.96) than children without such contacts. In univariate analysis, both the weekly amount of contact with dogs and cats and the average yearly amount of contact were associated with decreased respiratory infectious disease morbidity.

CONCLUSIONS: These results suggest that dog contacts may have a protective effect on respiratory tract infections during the first year of life. Our findings support the theory that during the first year of life, animal contacts are important, possibly leading to better resistance to infectious respiratory illnesses during childhood. *Pediatrics* 2012;130:1–10

Respiratory infectious symptoms and diseases are frequent during the first of year life. They are usually caused by a virus, with human rhinovirus being the most common pathogen.[1–3] In previous reports, the frequency of respiratory tract infections has been estimated to vary between 3 and 6 episodes within the first year of life.[4–6]

A variety of factors, such as day care attendance,[7,8] older siblings[7,9,10] and lack of breastfeeding,[10–12] have been considered as possible risk factors for early respiratory tract infections. In addition, a parental history of asthma[13,14] and smoking[10,15–18] are thought to have a role in the child's susceptibility to infections and to respiratory symptoms. Earlier reports on the role of animal contacts on the prevalence of respiratory tract infections are sparse. Some previous studies have shown that dog contacts,[19,20] although not cat contacts,[15] seem to decrease the number of common cold episodes during childhood. However, pet ownership has also been considered a possible risk factor for frequent childhood respiratory tract infections in some reports.[21]

In the last 10 years, a large body of literature has evaluated the role of early childhood animal exposure, including household pets, in the risk of asthma or allergy in children.[22–24] We have previously reported a decreased tumor necrosis factor α–producing capacity at birth and in the first year of life in children exposed to indoor dogs in early life,[25] suggesting that exposure to dogs during early life may reduce innate immune responses already at birth. At the same time, virological studies have shown large differences in immune responses among the children exposed to viruses that cause a common cold, such as human rhinovirus; it seems to cause common colds for most children during childhood, whereas atopic children with the higher risk of persistent asthma have had more frequently severe infections with wheezing and altered immune response.[26] Thus, a better understanding of the interplay between pet-related exposures and the development of early respiratory tract infections may provide indirect insight regarding the factors affecting the maturation of immune responses and its disturbances, such as asthma. In addition, recognizing the risk factors for respiratory tract infections during childhood is important because there might be a connection between childhood respiratory tract infections and chronic airway diseases later in adulthood.[21]

The aim of this study was to describe the effect of domestic animal contacts on respiratory tract infection morbidity during the first year of life. The study was based on a prospective birth cohort study with diary-based data on respiratory tract infections and animal exposures during the first year of life.

METHODS

The primary study population consisted of Finnish participants in a prospective birth cohort study, PASTURE (Protection Against Allergy in Rural Environments), which is an ongoing international study in 5 different European countries (Austria, Finland, France, Germany, and Switzerland). The Finnish study population consists of 208 children whose mothers were followed up from the third trimester of pregnancy. The mothers lived in rural areas, either on a farm or in a nonfarming environment. The cohort has been described in more detail elsewhere.[27] Another 216 mothers and their children (the extended Finnish cohort) were followed up through the same extensive protocol as the primary study population. The mothers lived in either rural or suburban environments, and all gave birth at Kuopio University Hospital. All the study children were born between September 2002 and May 2005.

The children's parents were given diary questionnaires consisting of questions related to infectious symptoms and health care attendance as well as on the children's dog and cat contacts. The diary questionnaires were filled in weekly, beginning from the ninth postnatal week and continuing up to the 52nd week, providing a total of 44 weeks of diary entries. In the diary questionnaires, parents were asked if their children had been "hale and hearty" during the previous 7 days. If the child had not been completely healthy, the parents also filled in a weekly questionnaire concerning different infectious diseases and symptoms (whether the child had had cough, wheezing of breath, rhinitis, fever $\geq$38.5°C, middle ear infection, diarrhea, urinary tract infection, itchy rash, or some other illness during these last 7 days). In this analysis, we evaluated respiratory infectious symptoms (cough, wheezing of breath, rhinitis, and fever) and infections (middle ear infection). Any children for whom there were less than one-half the number of possible diary entries during the study period ($<$23 weeks) were excluded (n = 27). Thus, 397 children were included in the following analyses.

Families were asked in the weekly questionnaires whether they had a dog or a cat at home and how much time it had spent inside daily. For the following analysis, dog and cat contacts indoor at home were grouped into: (1) no contact at all; (2) low contact (pet inside at home up to a maximum of 6 hours daily); (3) medium contact (pet inside from 6–16 hours daily); and (4) high contact (pet inside $>$16 hours daily). Breastfeeding was reported in 3 categories weekly: the child had either been solely breastfed, partly breastfed, or not breastfed at all.

We further evaluated the estimated average amount of daily dog and cat contacts during the study period by

using a self-administered retrospectively collected 1-year questionnaire, which was collected from the mothers when the children were 12 months old. The estimated average amount of daily dog and cat contacts was grouped as follows: (1) no dog/cat at all or dog/cat never inside at home; (2) dog/cat occasionally inside at home; (3) dog/cat often inside at home; or (4) dog/cat mostly inside at home. The analysis also included those children with both dog and cat contacts.

Additional data were collected from questionnaires during pregnancy and early childhood. Children were divided into 4 groups depending on the birth month: summer (June–August), autumn (September–November), winter (December–February), and spring (March–May). The birth weight was categorized into tertiles: <3480g, 3480 to <3810 g, and ≥3810 g. The number of older siblings was also categorized into 3 groups: no siblings, 1 sibling, or ≥2 siblings. Information concerning maternal smoking 2 months after delivery was requested in the 2- month questionnaire: yes versus no. Parental atopy was categorized as yes if the mother or father had ever been diagnosed with asthma, allergic eczema, or rhinitis, or no if neither of the parents had ever had any of those diagnoses. The choice of families of whether to keep pets was categorized yes versus no. Both maternal and paternal educational levels were categorized into 3 groups: (1) elementary or vocational school; (2) high school or college; or (3) university.

When data on animal contacts or information on the health, respiratory symptoms, and infections were missing from a diary, the week in question was excluded from the analysis. The same was done with other missing data if the information was not reliably derivable from other sources (eg, missing breastfeeding status from previous or subsequent weeks).

Statistical Methods

Data analysis was performed by using PASW statistics version 18.0 (SPSS Inc, Chicago, IL). The comparison of the frequencies of the healthy weeks and duration of the various respiratory diseases or symptoms with different baseline and risk factors was performed by using the χ^2 test or the Kruskall-Wallis test. Generalized estimating equations (GEE) were used to investigate the relationships between the prevalence of respiratory disease or symptoms during the follow-up and various predictive factors. The working correlation matrix was AR(1). In the multivariate GEE models, potential confounding variables were selected a priori on the basis of biological plausibility. These variables included: gender (male versus female), living environment (farm, rural nonfarming versus suburban), number of siblings (0, 1, vs >1), maternal smoking (yes versus no), parental atopy (yes versus no), breastfeeding (solely, partly versus no), birth weight (<3480, 3480 to <3810 vs ≥3810 g), season of birth (winter, spring, summer, autumn), diary month, and cohort (Finnish PASTURE [Protection Against Allergy in Rural Environments] versus extended Finnish cohort). Contacts with dogs or cats at home were also determined according to the amount of the time that the animals had spent inside the house daily. The cutoff level for significance was set at 0.05.

TABLE 1 Baseline Characteristics of Study Population in Relation to Living Environment

Characteristic	Farm	Rural Nonfarming	Suburban	All	*P*
No. of diary weeks	5002	8133	3989	17 124	
Gender, % male	46.0	52.5	48.6	49.7	<.001
Gestational weeks at birth	39.5 ± 1.2	39.6 ± 1.1	39.4 ± 1.3	39.6 ± 1.2	<.001
Birth weight (g)	3714 ± 444	3650 ± 469	3559 ± 463	3648 ± 464	<.001
Birth season					<.001
Winter	30.6	30.0	23.4	28.6	
Spring	33.6	30.1	23.1	29.5	
Summer	8.7	13.9	30.8	16.3	
Autumn	27.1	26.0	22.7	25.6	
No. of siblings	1.4 ± 1.5	1.3 ± 1.8	0.8 ± 1.1	1.2 ± 1.6	<.001
Parental atopy	46.5	53.0	68.8	54.8	<.001
Maternal education					<.001
Elementary/vocational school	33.7	33.7	27.8	32.3	
High school/college	48.1	46.4	45.8	46.8	
University	18.2	19.8	26.4	20.9	
Paternal education					<.001
Elementary/vocational school	69.3	58.7	48.4	59.6	
High school/college	26.6	28.0	25.2	27.0	
University	4.1	13.2	26.4	13.4	
Maternal smoking at 2 mo	3.5	8.0	7.4	6.5	<.001
Breastfeeding					.04
Solely	14.1	15.0	13.5	14.4	
Partly	42.4	40.2	42.2	41.3	
No	43.6	44.7	44.3	44.3	
Dog contacts at home					<.001
No dog or dog not inside	65.4	66.3	76.4	68.4	
Dog inside <6 h/d	11.2	4.3	4.2	6.3	
Dog inside 6–16 h/d	12.1	9.0	1.4	8.1	
Dog inside >16 h/d	11.3	20.3	18.0	17.2	
Cat contacts at home					<.001
No cat or cat not inside	56.5	86.2	84.3	77.2	
Cat inside <6 h/d	18.2	2.3	1.8	6.8	
Cat inside 6–16 h/d	15.0	5.5	1.5	7.3	
Cat inside >16 h/d	10.3	5.9	12.5	8.7	
Contacts with other children	47.5	56.3	55.5	53.6	<.001
Day care attendance at age 1 y	13.7	16.5	21.4	16.8	<.001

Data are presented as the mean ± SD or percentage. *P* values were obtained by using Pearson χ^2 or Kruskal-Wallis tests.

TABLE 2 Healthy Weeks and Weeks With Different Respiratory Tract Symptoms and Infections and Use of Antibiotics During Follow-up in Relation to Dog and Cat Contacts Based on Weekly Diary Data

Dog or Cat Contact	Healthy		Fever		Antibiotics		Wheezing		Cough		Otitis		Rhinitis	
	N	*n* (%)	*N*	*n* (%)	*N*	*n* (%)	*N*	*n* (%)	*N*	*n* (%)	*N*	*n* (%)	*N*	*n* (%)
Dog contacts at home														
No dog or dog not inside	11 569	7500 (64.8)	11143	493 (4.4)	11569	471 (4.1)	11143	231 (2.1)	11142	1256 (11.3)	11143	339 (3.0)	11143	2045 (18.4)
Dog inside <6 h/d	1063	805 (75.7)	1047	34 (3.2)	1063	20 (1.9)	1047	19 (1.8)	1047	88 (8.4)	1047	9 (0.9)	1047	142 (13.6)
Dog inside 6–16 h/d	1374	1020 (74.2)	1361	48 (3.5)	1374	45 (3.3)	1361	17 (1.2)	1361	132 (9.7)	1361	17 (1.2)	1361	202 (14.8)
Dog inside >16 h/d	2909	2101 (72.2)	2865	105 (3.7)	2909	86 (3.0)	2865	67 (2.3)	2865	286 (10.0)	2865	60 (2.1)	2865	502 (17.5)
P	<.001		.06		<.001		.12		.006		<.001		<.001	
Cat contacts at home														
No cat or cat not inside	13 061	8628 (66.1)	12632	526 (4.2)	13061	497 (3.8)	12632	269 (2.1)	12631	1400 (11.1)	12632	339 (2.7)	12632	2300 (18.2)
Cat inside <6 h/d	1144	895 (78.2)	1131	38 (3.4)	1144	20 (1.7)	1131	16 (1.4)	1131	68 (6.0)	1131	16 (1.4)	1131	131 (11.6)
Cat inside 6–16 h/d	1236	858 (69.4)	1198	50 (4.2)	1236	50 (4.0)	1198	22 (1.8)	1198	140 (11.7)	1198	28 (2.3)	1198	217 (18.1)
Cat inside >16 h/d	1474	1044 (70.8)	1455	68 (4.7)	1474	57 (3.9)	1455	28 (1.9)	1455	153 (10.5)	1455	44 (3.0)	1455	242 (16.6)
P	<.001		.43		.004		.38		<.001		.046		<.001	

N, total number of weeks with particular animal exposure; *n*, total number of weeks with specific symptom or infection and percentage (%) of weeks with specific symptom or infection from the total population with particular animal exposure; *P* values are obtained by Pearson Chi-Square test.

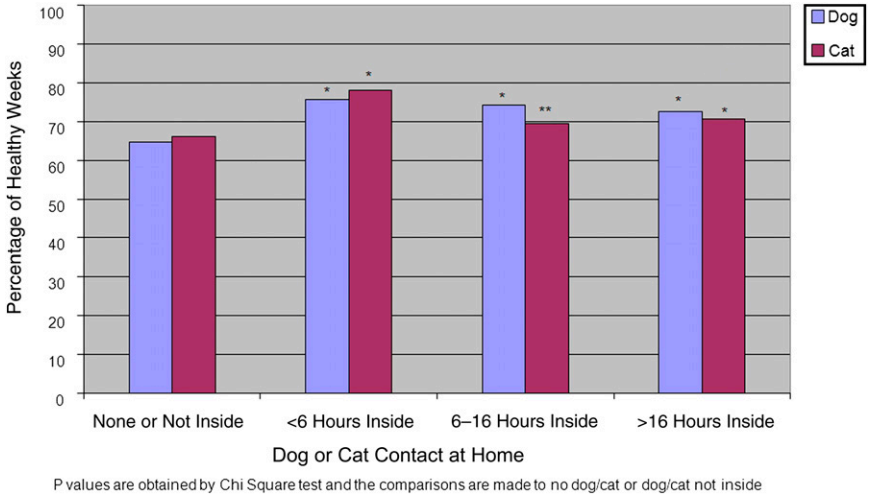

FIGURE 1
The percentage of healthy weeks in relation to average amount of dog or cat contacts at home. *$P < .01$; **$P < .05$.

Ethical Approval

The parents of all the children involved in the study gave their written informed consent. The research protocol was approved by the Research Ethics Committee of the Hospital District of Northern Savo (Kuopio, Finland).

RESULTS

In total, information was received for a total of 17 124 follow-up weeks recorded from the 397 children. More weekly questionnaires were completed at the beginning of the follow-up: the number varied from 396 forms in weeks 7, 11, 12, 17, and 18 to 347 forms in week 44. Of the 44 follow-up weeks, the mean number of completed weeks was 43.0 per child (range: 23–44 weeks), with 94.2% of families filling in at least 40 forms.

Table 1 shows the baseline characteristics and animal contacts of the 397 study children presented as diary weeks in relation to living environment. There were significant differences in all shown confounding variables between different living environments, and thus the living environment variable was further selected as a confounder in the multivariate analysis.

Infectious Respiratory Symptoms

Four children were reported as having been healthy during the whole study period, and 15.6% of the children (n = 62) were healthy for less than one-half of the follow-up weeks. In total, 285 (71.8%) children had had fever, 157 (39.5%) a middle ear infection, 384 (96.7%) rhinitis, 335 (84.4%) cough, and 128 (32.2%) wheezing during any time of the study period. In addition, nearly one-half of the children (n = 189 [47.6%]) needed systemic antibiotics in the course of the 44-week study period. The most frequently reported disease was rhinitis, which occurred in 17.0% of the follow-up weeks. Cough occurred in 10.4%, fever in 4.0%, wheezing in 2.0%, and middle ear infection in 2.5% of the follow-up weeks. Two children had pneumonia during the follow-up.

Cat and Dog Contacts

Of 397 children, 245 (61.7%) had had dog and 136 (34.3%) had had cat contact at home at some time during the study

period (range: 1–44 weeks). However, dog contacts at home were not stable: during the study weeks 1, 22, and 44, the percentages of children living with no dog or no cat contact in the home varied from 66.1% to 69.3% and 76.1% to 77.4%, respectively. According to the 1-year retrospective questionnaire at the end of the study period, 65.2% of the children lived mainly in homes with no dog contact and 75.5% in homes with no cat contact. During the pregnancy, 22.7% of families reported pet animal avoidance due to allergic symptoms in the family.

If children had dog or cat contacts at home, they were significantly healthier during the study period in univariate tests (both $P < .001$) (Table 2, Fig 1) and had fewer weeks with cough, otitis, and rhinitis and also needed fewer courses of antibiotics than children with no cat or dog contacts at all. The number of study weeks with different respiratory tract symptoms and

TABLE 3 Healthy Weeks and the Weeks With Different Respiratory Tract Symptoms and Infections and Use of Antibiotics During Follow-up in Relation to Dog and Cat Contacts Based on Retrospective Cross-Sectional Data of Average Animal Contacts During the Study

Dog or Cat Contact	Healthy		Fever		Antibiotics		Wheezing		Cough		Otitis		Rhinitis	
	N	*n* (%)	*N*	*n* (%)	*N*	*n* (%)	*N*	*n* (%)	*N*	*n* (%)	*N*	*n* (%)	*N*	*n* (%)
Dog contacts at home														
No dog or dog not inside	10 798	6878 (63.7)	10361	447 (4.3)	10798	468 (4.3)	10 361	231 (2.2)	10360	1193 (11.5)	10 361	331 (3.2)	10 361	1918 (18.5)
Dog occasionally inside	1278	953 (74.6)	1269	57 (4.5)	1278	14 (1.1)	1269	20 (1.6)	1269	135 (10.6)	1269	7 (0.6)	1269	225 (17.7)
Dog often inside	1391	1132 (81.4)	1390	53 (3.8)	1391	36 (2.6)	1390	16 (1.2)	1390	109 (7.8)	1390	12 (0.9)	1390	155 (11.2)
Dog mostly inside	3113	2229 (71.6)	3066	102 (3.3)	3113	93 (3.0)	3066	59 (1.9)	3066	313 (10.2)	3066	65 (2.1)	3066	537 (17.5)
P		<.001		.08		<.001		.03		<.001		<.001		<.001
Cat contacts at home														
No cat or cat not inside	12 643	8278 (65.5)	12191	500 (4.1)	12643	511 (4.0)	12 191	263 (2.2)	12190	1369 (11.2)	12 191	342 (2.8)	12 191	2233 (18.3)
Cat occasionally inside	884	726 (82.1)	884	32 (3.6)	884	12 (1.4)	884	14 (1.6)	884	57 (6.4)	884	9 (1.0)	884	101 (11.4)
Cat often inside	1734	1239 (71.5)	1705	77 (4.5)	1734	45 (2.6)	1705	32 (1.9)	1705	179 (10.5)	1705	35 (2.1)	1705	301 (17.7)
Cat mostly inside	1451	1039 (71.6)	1438	59 (4.1)	1451	49 (3.4)	1438	24 (1.7)	1438	159 (11.1)	1438	33 (2.3)	1438	237 (16.5)
P		<.001		.74		<.001		.40		<.001		.004		<.001

N, total number of weeks with particular animal exposure; *n*, total number of weeks with specific symptom or infection and percentage (%) of weeks with specific symptom or infection from the total population with particular animal exposure; *P* values are obtained by Pearson Chi-Square test.

TABLE 4 Multivariate Results of the Association Between Animal Contacts and Overall Healthiness, Fever, and Antibiotic Usage Based on Collection of Weekly Diary Data

Dog or Cat Contact	Healthy				Fever				Antibiotics			
	N	*n* (%)	aOR (95% CI)[a]	*P*	*N*	*n* (%)	aOR (95% CI)[a]	*P*	*N*	*n* (%)	aOR (95% CI)[a]	*P*
Dog contact at home												
No	11 569	7500 (64.8)	1		11 143	493 (4.4)	1		11 569	471 (4.1)	1	
Yes	5346	3926 (73.4)	1.31 (1.13–1.52)	<.001	5273	187 (3.5)	0.80 (0.66–0.98)	.03	5346	151 (2.8)	0.71 (0.52–0.96)	.03
Amount of dog contacts at home												
No dog or dog not inside	11 569	7500 (64.8)	1		11 143	493 (4.4)	1		11 569	471 (4.1)	1	
Dog inside <6 h/d	1063	805 (75.7)	1.25 (1.04–1.50)	.02	1047	34 (3.2)	0.63 (0.41–0.97)	.04	1063	20 (1.9)	0.54 (0.34–0.87)	.01
Dog inside 6–16 h/d	1374	1020 (74.2)	1.21 (0.93–1.57)	.16	1361	48 (3.5)	0.85 (0.63–1.15)	.30	1374	45 (3.3)	0.91 (0.52–1.59)	.73
Dog inside >16 h/d	2909	2101 (72.2)	1.41 (1.14–1.74)	.001	2865	105 (3.7)	0.87 (0.68–1.11)	.25	2909	86 (3.0)	0.72 (0.49–1.04)	.08
Cat contact at home												
No	13 061	8628 (66.1)	1		12 632	526 (4.2)	1		13 061	497 (3.8)	1	
Yes	3854	2797 (72.6)	1.06 (0.88–1.29)	.53	3784	156 (4.1)	1.00 (0.79–1.27)	>.99	3854	127 (3.3)	0.98 (0.61–1.59)	.95
Amount of cat contacts at home												
No cat or cat not inside	13 061	8628 (66.1)	1		12 632	526 (4.2)	1		13 061	497 (3.8)	1	
Cat inside <6 h/d	1144	895 (78.2)	1.13 (0.86–1.47)	.38	1131	38 (3.4)	0.83 (0.56–1.24)	.37	1144	20 (1.7)	0.65 (0.37–1.17)	.15
Cat inside 6–16 h/d	1236	858 (69.4)	1.01 (0.77–1.32)	.94	1198	50 (4.2)	0.97 (0.69–1.38)	.87	1236	50 (4.0)	1.06 (0.48–2.33)	.88
Cat inside >16 h/d	1474	1044 (70.8)	1.06 (0.81–1.38)	.69	1455	68 (4.7)	1.13 (0.83–1.55)	.44	1474	57 (3.9)	1.13 (0.67–1.90)	.65

Values are aORs and 95% CIs obtained by using GEE analysis, working correlation matrix AR(1). *N*, total number of weeks with particular animal exposure; *n*, total number of weeks with specific symptom or infection and percentage (%) of weeks with specific symptom or infection from the total population with particular animal exposure.

[a] All the aORs were adjusted for gender, birth weight, season of birth, parental atopy, number of siblings, cohort, maternal smoking, breastfeeding, living environment, and diary month.

TABLE 5 Multivariate Results of the Association Between Animal Contacts and Different Respiratory Tract Symptoms and Infections Based on Weekly Diary Data Collection

Dog or Cat Contact	Wheezing				Cough				Otitis				Rhinitis			
	N	*n* (%)	aOR (95% CI)[a]	*P*	*N*	*n* (%)	aOR (95% CI)[a]	*P*	*N*	*n* (%)	aOR (95% CI)[a]	*P*	*N*	*n* (%)	aOR (95% CI)[a]	*P*
Dog contact at home																
No	11 143	231 (2.1)	1		11142	1256 (11.3)	1		11143	339 (3.0)	1		11 143	2045 (18.4)	1	
Yes	5273	103 (2.0)	0.87 (0.61–1.24)	.44	5273	506 (9.6)	0.85 (0.70–1.03)	.10	5273	86 (1.6)	0.56 (0.38–0.81)	.002	5273	846 (16.0)	0.92 (0.79–1.07)	.26
Amount of dog contacts at home																
No dog or dog not inside	11 143	231 (2.1)	1		11 142	1256 (11.3)	1		11143	339 (3.0)	1		11 143	2045 (18.4)	1	
Dog inside <6 h/d	1047	19 (1.8)	0.84 (0.53–1.33)	.46	1047	88 (8.4)	0.75 (0.55–1.01)	.06	1047	9 (0.9)	0.38 (0.18–0.82)	.01	1047	142 (13.6)	0.81 (0.64–1.03)	.08
Dog inside 6–16 h/d	1361	17 (1.2)	0.61 (0.29–1.27)	.18	1361	132 (9.7)	1.00 (0.70–1.42)	.99	1361	17 (1.2)	0.53 (0.29–0.97)	.04	1361	202 (14.8)	0.93 (0.73–1.19)	.56
Dog inside >16 h/d	2865	67 (2.3)	0.99 (0.60–1.64)	.97	2865	286 (10.0)	0.87 (0.68–1.10)	.24	2865	60 (2.1)	0.67 (0.41–1.08)	.10	2865	502 (17.5)	0.99 (0.81–1.21)	.91
Cat contact at home																
No	12 632	269 (2.1)	1		12 631	1400 (11.1)	1		12632	339 (2.7)	1		12 632	2300 (18.2)	1	
Yes	3784	66 (1.7)	1.02 (0.66–1.57)	.95	3784	361 (9.5)	1.07 (0.84–1.35)	.60	3784	88 (2.3)	1.02 (0.67–1.55)	.92	3784	590 (15.6)	0.95 (0.79–1.14)	.57
Amount of cat contacts at home																
No cat or cat not inside	12 632	269 (2.1)	1		12 631	1400 (11.1)	1		12 632	339 (2.7)	1		12 632	2300 (18.2)	1	
Cat inside <6 h/d	1131	16 (1.4)	0.94 (0.48–1.83)	.85	1131	68 (6.0)	0.85 (0.62–1.17)	.32	1131	16 (1.4)	0.75 (0.39–1.44)	.39	1131	131 (11.6)	0.81 (0.62–1.06)	.13
Cat inside 6–16 h/d	1198	22 (1.8)	0.89 (0.48–1.65)	.71	1198	140 (11.7)	1.19 (0.85–1.68)	.31	1198	28 (2.3)	0.91 (0.47–1.74)	.76	1198	217 (18.1)	1.00 (0.77–1.28)	.97
Cat inside >16 h/d	1455	28 (1.9)	1.17 (0.66–2.08)	.59	1455	153 (10.5)	1.12 (0.82–1.52)	.48	1455	44 (3.0)	1.29 (0.77–2.15)	.34	1455	242 (16.6)	1.02 (0.79–1.31)	.91

Values are aORs and 95% CIs obtained by using GEE analysis, working correlation matrix AR(1). *N*, total number of weeks with particular animal exposure. *n*, total number of weeks with specific symptom or infection and percentage (%) of weeks with specific symptom or infection from the total population with particular animal exposure.

[a] All the aORs were adjusted for gender, birth weight, season of birth, parental atopy, number of siblings, cohort, maternal smoking, breastfeeding, living environment, and diary month.

infections was also compared with 1-year questionnaire data on cat and dog contacts (Table 3), and the results were comparable to the results of the animal contact data from the diary (Table 2).

The multivariate analysis was conducted longitudinally (Tables 4 and 5) and cross-sectionally (Tables 6 and 7), by using GEE models. Even after adjusting for possible confounders, children having a dog at home were significantly healthier, had less frequent otitis, and tended to need fewer courses of antibiotics during the study period than children without dog contacts. Both the weekly amount of dog contacts (according to diary data) and the average amount of yearly contact (according to 1-year questionnaire data) with dogs was associated similarly with decreasing respiratory infectious disease morbidity. The highest protective association between dog ownership and healthiness, as well as lower risk for antibiotic use, otitis and rhinitis was detected among children who had a dog inside at home for <6 hours daily (according to diary data) or had a dog temporally or often inside (according to retrospective data) compared with those who did not have any dogs or dogs were not inside (Tables 4, 5, 6, and 7). In sensitivity analysis, the associations did not change after we removed from analysis those children whose families reported avoidance of pets due to some allergic causes (data not shown).

DISCUSSION

According to our results, dog and cat contacts during early infancy may be associated with less morbidity in general (indicated as more healthy weeks) and concomitantly may have a protective effect on respiratory tract symptoms and infections. In comparisons between cat and dog contacts, dog contacts showed a more significant protective role on respiratory infectious

TABLE 6 Multivariate Results of the Association Between Animal Contacts and Overall Healthiness, Fever, and Antibiotic Usage Based on Collection of Cross-sectional Data of Average Animal Contacts During the Study

Dog or Cat Contact	Healthy				Fever				Antibiotics			
	N	*n* (%)	aOR (95% CI)[a]	*P*	*N*	*n* (%)	aOR (95% CI)[a]	*P*	*N*	*n* (%)	aOR (95% CI)[a]	*P*
Dog contacts at 1 y age												
No dog or dog not inside	10 798	6878 (63.7)	1		10 361	447 (4.3)	1		10 798	468 (4.3)	1	
Dog temporally inside	1278	953 (74.6)	1.46 (1.07–2.00)	0.02	1269	57 (4.5)	1.04 (0.70–1.53)	.86	1278	14 (1.1)	0.28 (0.14–0.59)	.001
Dog often inside	1391	1132 (81.4)	2.08 (1.44–3.00)	<0.001	1390	53 (3.8)	0.84 (0.62–1.14)	.27	1391	36 (2.6)	0.61 (0.28–1.35)	.61
Dog mostly inside	3113	2229 (71.6)	1.34 (1.05–1.70)	0.02	3066	102 (3.3)	0.86 (0.65–1.14)	.29	3113	93 (3.0)	0.74 (0.51–1.08)	.12
Cat contacts at 1 y age												
No cat or cat not inside	12 643	8278 (65.5)	1		12 191	500 (4.1)	1		12 643	511 (4.0)	1	
Cat temporally inside	884	726 (82.1)	1.64 (1.12–2.39)	0.01	884	32 (3.6)	0.83 (0.53–1.28)	.39	884	12 (1.4)	0.37 (0.18–0.76)	.007
Cat often inside	1734	1239 (71.5)	1.04 (0.79–1.37)	0.79	1705	77 (4.5)	1.08 (0.79–1.47)	.64	1734	45 (2.6)	0.67 (0.39–1.14)	.14
Cat mostly inside	1451	1039 (71.6)	1.15 (0.85–1.58)	0.37	1438	59 (4.1)	1.06 (0.76–1.49)	.72	1451	49 (3.4)	0.93 (0.51–1.70)	.82

Values are aORs and 95% CIs obtained by using GEE analysis, working correlation matrix AR(1). *N*, total number of weeks with particular animal exposure; *n*, total number of weeks with specific symptom or infection and percentage (%) of weeks with specific symptom or infection from the total population with particular animal exposure.

[a] All the aORs were adjusted for gender, birth weight, season of birth, parental atopy, number of siblings, cohort, maternal smoking, breastfeeding, living environment, and diary month.

disease morbidity. To our knowledge, this is the first study that has evaluated the significance of pet contacts during childhood for the development of respiratory tract infections and, furthermore, has made analyses by using 2 different data collection methods for information on animal contact. This study also made possible evaluation of the effects of different lengths of animal contacts, by using short time variations, on the risk of respiratory tract illnesses.

The results support those of Hatakka et al,[20] who reported that furred pets would decrease the risk of recurrent acute respiratory tract symptoms with children 1 to 6 years old, although some reports have found no association between respiratory tract infections and pet keeping.[28] Our current results also support indirectly those of Grüber et al,[19] who found that having a dog at home during the first 2 years of life decreased the number of common cold episodes among 0- to 2-year-olds. We showed that children who had dog contacts at home had less otitis and rhinitis and more healthy weeks than children without dog contacts at home, but having a dog at home during the first postnatal year had no significant role in the occurrence of wheezing and cough, which is in line with earlier results,[29] even though the reason for these findings is obscure.

Cat ownership seemed to also have an overall protective effect, although weaker than dog ownership, on the infectious health of infants. Similarly, in some earlier studies, exposure to cats has been considered a protective factor toward wheezing in the first year of life,[13] as well as for croup with older children.[30] On the contrary, many studies have shown that cat contacts have no effect on infectious symptoms[15,29] or wheeze among children.[31] In line with this, the association between exposure to cats and respiratory tract symptoms and infections during childhood was decreased in our study after confounding in multivariate analysis. It is unsure why cat exposure is less significant compared with dog exposure. However, Heyworth et al[32] have shown that cat and/or dog ownership is also associated with a reduced risk of gastroenteritis. This finding could indicate a real relationship exists between animal contacts and the frequency of infections among children.

We also showed that children living in houses in which dogs spend only part of the day inside (defined as <6 hours or temporally) had the lowest risk of infectious symptoms and respiratory tract infections. A possible explanation for this interesting finding might be that the amount of dirt brought inside the home by dogs could be higher in these families because they spent more time outdoors. In other words, less dirt is brought indoors by dogs who mainly live indoors. The living environment could also affect the amount of dirt and animal contacts. Hence, we did a subanalysis and evaluated the effect of animal contacts on overall healthiness separately for children living in rural and suburban environments. The directions of associations did not change, although some of the associations weakened slightly, as well as some got stronger. Furthermore, we included the area of living as a covariate in the multivariate analysis, and the associations between dog exposure and health variables remained. The amount of dirt is likely to correlate

TABLE 7 Multivariate Results of the Association Between Animal Contacts and Different Respiratory Tract Symptoms and Infections Based on Retrospective Cross-sectional Data of Average Animal Contacts During the Study

Dog or Cat Contact	Wheezing				Cough				Otitis				Rhinitis			
	N	*n* (%)	aOR (95% CI)[a]	*P*	*N*	*n* (%)	aOR (95% CI)[a]	*P*	*N*	*n* (%)	aOR (95% CI)[a]	*P*	*N*	*n* (%)	aOR (95% CI)[a]	*P*
Dog contacts at age 1 y																
No dog or dog not inside	10 361	231 (2.2)	1		10 360	1193 (11.5)	1		10 361	331 (3.2)	1		10 361	1918 (18.5)	1	
Dog temporally inside	1269	20 (1.6)	0.91 (0.49–1.70)	.77	1269	135 (10.6)	1.03 (0.69–1.52)	.90	1269	7 (0.6)	0.17 (0.07–0.42)	<.001	1269	225 (17.7)	0.99 (0.74–1.32)	.93
Dog often inside	1390	16 (1.2)	0.47 (0.20–1.09)	.08	1390	109 (7.8)	0.73 (0.44–1.19)	.21	1390	12 (0.9)	0 27 (0.12–0.63)	.003	1390	155 (11.2)	0.60 (0.44–0.83)	.002
Dog mostly inside	3066	59 (1.9)	0.86 (0.48–1.51)	.59	3066	313 (10.2)	0.95 (0.73–1.25)	.73	3066	65 (2.1)	0.75 (0.47–1.18)	.21	3066	537 (17.5)	1.02 (0.83–1.26)	.85
Cat contacts at age 1 y																
No cat or cat not inside	12 191	263 (2.2)	1		12 190	1369 (11.2)	1		12 191	342 (2.8)	1		12 191	2233 (18.3)	1	
Cat temporally inside	884	14 (1.6)	0.93 (0.34–2.60)	.90	884	57 (6.4)	0.74 (0.41–1.32)	.30	884	9 (1.0)	0.41 (0.16–1.01)	.05	884	101 (11.4)	0.70 (0.45–1.09)	.11
Cat often inside	1705	32 (1.9)	0.99 (0.50–1.96)	.97	1705	179 (10.5)	1.09 (0.74–1.61)	.66	1705	35 (2.1)	0.76 (0.40–1.46)	.42	1705	301 (17.7)	1.07 (0.80–1.41)	.66
Cat mostly inside	1438	24 (1.7)	0.99 (0.53–1.82)	.96	1438	159 (11.1)	1.13 (0.78–1.64)	.51	1438	33 (2.3)	0.89 (0.51–1.57)	.69	1438	237 (16.5)	0.96 (0.74–1.25)	.76

Values are aORs and 95% CIs obtained by using GEE analysis, working correlation matrix AR(1). *N*, total number of weeks with particular animal exposure. *n*, total number of weeks with specific symptom or infection and percentage (%) of weeks with specific symptom or infection from the total population with particular animal exposure.

[a] All the aORs were adjusted for gender, birth weight, season of birth, parental atopy, number of siblings, cohort, maternal smoking, breastfeeding, living environment, and diary month.

with bacterial diversity in the living environment, possibly affecting the maturation of the child's immune system and further affecting the risk of respiratory tract infections. However, in this article, we could not objectively analyze the actual role of bacterial diversity, which will have to be the subject of further studies.

There are several possible reasons why the reported associations between pet ownership and respiratory tract infections during childhood are inconsistent. First, the different types of pet animals have not been evaluated separately in the analyses.[5,16,20,21,28] Second, some studies enrolled older children. For example, Burr et al[16] found that pet ownership increased the risk of wheezing, rhinitis, and the number of cold episodes per year for 12- to 14-year-olds. Third, studies have evaluated the associations between respiratory tract infections and animal contacts during childhood retrospectively.[21] Our study was prospective in nature, and we also analyzed results by using data collected with 2 different methods, thus making our results more reliable.

Lastly, it is possible that the effect of animal contacts on the frequency of respiratory tract symptoms is mediated by a choice among atopic parents to not keep pets.[20,33] We included parental atopy as a confounder in the multivariate analysis, and the association was not diminished. When we repeated the analyses without subjects with a reported family history of pet avoidance, associations were not changed. As a whole, predictions on pet-keeping data are not straightforward, and there are studies showing that atopic families do not necessarily avoid keeping pets.[34] However, the influence of possible atopic predisposition of the study children on the results cannot be completely ruled out.

Evidence suggests that animal contacts, especially during early life, might be

crucial in immunity developing along a nonallergic route[24,35] and in ensuring effective responses to respiratory viral infections in early life.[35,36] We speculate that animal contacts could help to mature the immunologic system, leading to more composed immunologic response and shorter duration of infections. We offer preliminary evidence that dog ownership may be protective against respiratory tract infections during the first year of life.

CONCLUSIONS

To our knowledge, this is the first prospective study in which the frequencies of respiratory infectious symptoms and diseases are compared with weekly amounts of pet contacts in a diary follow-up manner during early infancy. Our results suggest that dog contacts protect children from respiratory tract infections during the first year of life.

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