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Clinical Communications

Effect of prenatal dog exposure on eczema development in early and late childhood

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Clinical Implications

Dog exposure is protective in early eczema development, but effects in late childhood are unknown. We find that prenatal and first-year dog exposure has a significant protective effect on early eczema development by age 2 years.

Eczema in early childhood, often the start of the atopic march, increases the likelihood of developing subsequent atopic conditions (food allergy, allergic asthma, and allergic rhinitis).[1,2] Modifiable environmental risk factors, which are important to eczema pathogenesis, may represent potential interventions. Studies demonstrate the protective effects of domestic pets on eczema development.[3,4] Previous reports focused on eczema in early childhood but did not address potential effects in late childhood.[3,4] This study compares the associations of prenatal and first-year dog exposure to eczema in early childhood (age 2 years) and late childhood (age 10 years) in the Wayne County Health, Environment, Allergy, and Asthma Longitudinal study, a racially and socioeconomically diverse birth cohort. We also assessed whether prenatal dog exposure is associated with persistence or resolution of eczema from age 2 to 10 years and whether dogs are associated with atopic and nonatopic eczema.

The Wayne County Health, Environment, Allergy, and Asthma Longitudinal study enrolled pregnant women (aged 21-49 years) who were due September 2003 to December 2007 and resided in the metro-Detroit area. Participants provided informed consent, and study protocols were approved by the Henry Ford Health Institutional Review Board.[5] This analysis included maternal−child pairs who completed a prenatal interview and had the eczema history evaluated by a physician during study clinic visits at age 2 and/or 10 years (n = 794) (see Figure E1 in this article's Online Repository at www.jaci-inpractice.org). Using the patient's history and physical examination, physicians assessed each child's history of eczema over time. Early eczema only refers to an eczema diagnosis before or at age 2 years but no eczema at age 10 years. Late eczema only refers to a current eczema diagnosis at age 10 years but not at age 2 years or younger. Persistent eczema refers to an eczema diagnosis at age 2 years or younger with eczema present at age 10 years; if it was absent at age 10 years, the child was classified as having resolved eczema. Prenatal dog exposure was defined as one or more indoor dogs in the home for 1 hour/day or more during pregnancy for at least 1 week. Median dog exposure was beyond pregnancy at 24 months (interquartile range, 10-69 months). The presence of dogs in the first year of life was similarly defined. Serum allergen-specific IgE was measured for 10 common inhalant or food allergens at age 2 years (*Dermatophagoides farinae*, ragweed, *Alternaria alternata*, dog, cat, grass, cockroach, egg, milk, and peanut) and 11 allergens at age 10 years (dog, cat, cockroach, *Dermatophagoides pteronyssinus*, *D farinae*, ragweed, grass, mold mixture, egg, peanut, and milk). Atopy was defined as serum allergen-specific IgE of 0.35 IU/mL or greater to one or more allergens. Eczema was further refined as atopic eczema (early atopic eczema indicated early eczema and atopic at age 2 years; late atopic eczema indicated late eczema and atopic at age 10 years; and persistent atopic eczema indicated persistent eczema and atopic at 2 or 10 years). Nonatopic eczema was similarly defined.

TABLE I. Descriptive characteristics of children with known atopic dermatitis status at age 2 or 10 years (n = 794)

Variable	Level	n	%
Mother's eczema (ever in lifetime)	No	590	74.7
	Yes	200	25.3
Maternal race-ethnicity	Arabic	41	5.2
	Black	471	59.3
	Hispanic	47	5.9
	Other/mixed race*	36	4.5
	White	199	25.1
Mode of delivery	Vaginal	496	62.6
	Cesarean section	296	37.4
First-born child	No	495	62.3
	Yes	299	37.7
Prenatal indoor dog(s)	No	587	73.9
	Yes	207	26.1
Indoor dog(s) in first year of life	No	444	69.6
	Yes	194	30.4
Prenatal indoor cat(s)	No	657	82.8
	Yes	137	17.2
Prenatal environmental tobacco smoke exposure	No	609	76.7
	Yes	185	23.3
Eczema category	Never	255	64.7
	Early†	54	13.7
	Late‡	43	10.9
	Persistent§	42	10.7
Atopic at age 2 y	No	251	48.5
	Yes	266	51.5
Total IgE at age 2 y	Geometric mean (SD)	21.1 (4.2)	
Atopic at age 10 y	No	226	41.9
	Yes	314	58.2
Total IgE at age 10 y	Geometric mean (SD)	68.7 (4.9)	

*Other/mixed race includes those that do not fit in the other listed categories and smaller sample size groups including Asian, American Indian/Alaskan Native, and Pacific Islander.

†n = 21 with early atopic eczema, n = 18 with early nonatopic eczema, and n = 15 with missing atopy. status

‡n = 31 with late atopic eczema and n = 12 with late nonatopic eczema.

§n = 34 with persistent atopic eczema, n = 3 with persistent nonatopic eczema, and n = 5 with missing atopy status.

TABLE II. Association between dog exposure and eczema from ages 2 to 10 years

		Unadjusted			Adjusted		
Exposure	**Outcome**	**n**	**Odds ratio (95% CI)**	***P***	**n**	**Odds ratio (95% CI)**	***P***
Prenatal dog exposure	Early only vs never eczema	309	0.32 (0.14-0.74)	.008	240	0.28 (0.09-0.83)*	.022
	Early atopic vs never eczema	276	0.36 (0.1-1.25)	.107	220	0.48 (0.13-1.81)*	.277
	Early nonatopic vs never eczema	273	0.13 (0.02-0.97)	.046	217	N/A*†	N/A*†
	Late only vs never eczema	298	0.93 (0.46-1.88)	.842	294	1.36 (0.63-2.92)‡	.433
	Late atopic vs never eczema	286	1.02 (0.46-2.27)	.955	282	2.14 (0.84-5.46)‡	.111
	Late nonatopic vs never eczema	267	0.72 (0.19-2.72)	.624	263	0.47 (0.11-2.07)‡	.321
	Persistent vs never eczema	297	0.36 (0.15-0.88)	.026	230	0.32 (0.10-1.02)*	.053
	Persistent atopic vs never eczema	289	0.46 (0.18-1.16)	.098	225	0.41 (0.12-1.37)*	.148
	Persistent nonatopic vs never eczema	258	N/A†	N/A†	202	N/A*†	N/A*†
	Resolved eczema: yes vs no	96	0.89 (0.28-2.89)	.851	72	1.08 (0.21-5.54)*	.93
Dog exposure in first year of life	Early only vs never eczema	266	0.28 (0.11-0.69)	.006	211	0.22 (0.06-0.78)*	.019
	Early atopic vs never eczema	239	0.21 (0.05-0.94)	.042	195	0.33 (0.07-1.55)*	.16
	Early nonatopic vs never eczema	234	0.14 (0.02-1.06)	.057	190	N/A*†	N/A*†
	Late only vs never eczema	257	1.00 (0.48-2.06)	.997	255	1.31 (0.60-2.87)‡	.503
	Late atopic vs never eczema	246	1.13 (0.49-2.59)	.774	244	1.95 (0.74-5.15)‡	.177
	Late nonatopic vs never eczema	230	0.72 (0.19-2.79)	.635	228	0.6 (0.15-2.51)‡	.488
	Persistent vs never eczema	253	0.50 (0.21-1.20)	.119	200	0.45 (0.14-1.47)*	.187
	Persistent atopic vs never eczema	247	0.64 (0.26-1.57)	.331	196	0.61 (0.18-2.08)*	.428
	Persistent nonatopic vs never eczema	221	N/A†	N/A†	177	N/A*†	N/A*†
	Resolved eczema: yes vs no	81	0.56 (0.17-1.86)	.348	61	0.64 (0.10-3.98)*	.628

N/A, not applicable.
*Adjusted for maternal race-ethnicity, mode of delivery, prenatal indoor cats, and log(total IgE at age 2 years).
†Model did not converge.
‡Adjusted for maternal race-ethnicity, mode of delivery, prenatal indoor cats, and log(total IgE at age 10 years).

We used logistic regression to determine the association between keeping a dog and the occurrence of childhood eczema, in which the main effect *P* less than .05 was considered significant. Interaction terms were included to test *a priori* hypothesized effect modification (maternal eczema, maternal race-ethnicity, mode of delivery, first-born child, and prenatal environmental tobacco smoke exposure), with interaction *P* less than .10 considered significant. Models were refit after adjusting for potential confounders (*a priori* hypothesized as associated with dogs and eczema), with confounding indicated by an effect size change greater than 20%.

The rate of keeping dogs indoors was 26% prenatally, and rates of eczema at ages 2 and 10 were 22% and 21%, respectively (Table I). Among children with known eczema status at both time points (n = 394), 14% had early eczema only, 11% had late eczema only, and 11% had persistent eczema (Table I). In multivariable analyses, children with prenatal dog exposure had lower odds of early eczema only (adjusted odds ratio [aOR] [95% CI] = 0.28 [0.09-0.83]; *P* = .022) (Table II). This association was weaker and not statistically significant for late eczema only (aOR [95% CI] = 1.36 [0.63-2.92]; *P* = .433) (Table II) and did not reach statistical significance for persistent eczema after adjustment (aOR [95% CI] = 0.32 [0.10-1.02]; *P* = .053) (Table II). We then examined the impact of effect modifiers. The mode of delivery significantly modified the effect of dogs in the first year of life on early eczema development (interaction *P* = .056). Specifically, an effect was observed only among vaginally delivered children (OR [95% CI] = 0.07 [0.01-0.54]; *P* = .011) but not among children delivered by Cesarean section (OR [95% CI] = 0.68 [0.22-2.12]; *P* = .51); all other interaction *P*s were 0.10 or greater.

Previous studies revealed associations between prenatal and early-life dog exposures with the prevention of early childhood eczema.[3,4,6] Our study confirms this, with protective effects on early, but not late, childhood, and the strongest effect among children delivered vaginally. Although the effect size appeared to be larger for early nonatopic eczema than early atopic eczema, we were limited by the sample size to elucidate these differences fully. The effect of prenatal dog exposure on persistent eczema failed to reach significance after covariate adjustment. However, the effect size was strong (OR = 0.32) and warrants further exploration in larger studies.

Dogs may provide exposure to microbial diversity that is beneficial to immune development,[7] and alterations may influence immunologic mediators leading to atopic conditions.[6,7] The first year of life is potentially the critical window.[6] Our results suggest that *in utero* exposure may prevent early eczema. Most households with dogs during human pregnancy keep their pets during infancy, which makes the effects difficult to disentangle. Study strengths include its prospective nature and the large sample size. Moreover, it represents a racially and socioeconomically diverse population. We accounted for potentially modifiable factors that did not modify the overall effect except for the delivery mode. The lack of significant interactions could be due to the insufficient sample size. Some biases may include the loss to follow-up, which potentially biased effect estimates. Parents with allergic diseases may avoid domestic animal exposure, which could result in reverse causation. Because of limited data, we considered maternal rather than paternal eczema. The eczema prevalence in this study was higher than in previous reports.[8] However, eczema is reportedly more common in the Black population.[9]

Our data suggest that prenatal and early-life dog exposure has a significant protective effect on eczema development at or before age 2 years. Because keeping pets influences infant gut microbial composition,[7] the lower rate of eczema in dog-exposed children may be linked to altered early-life immune development triggered by microbial exposures. Clinically, our findings suggest that prenatal dog exposure could protect against early eczema.

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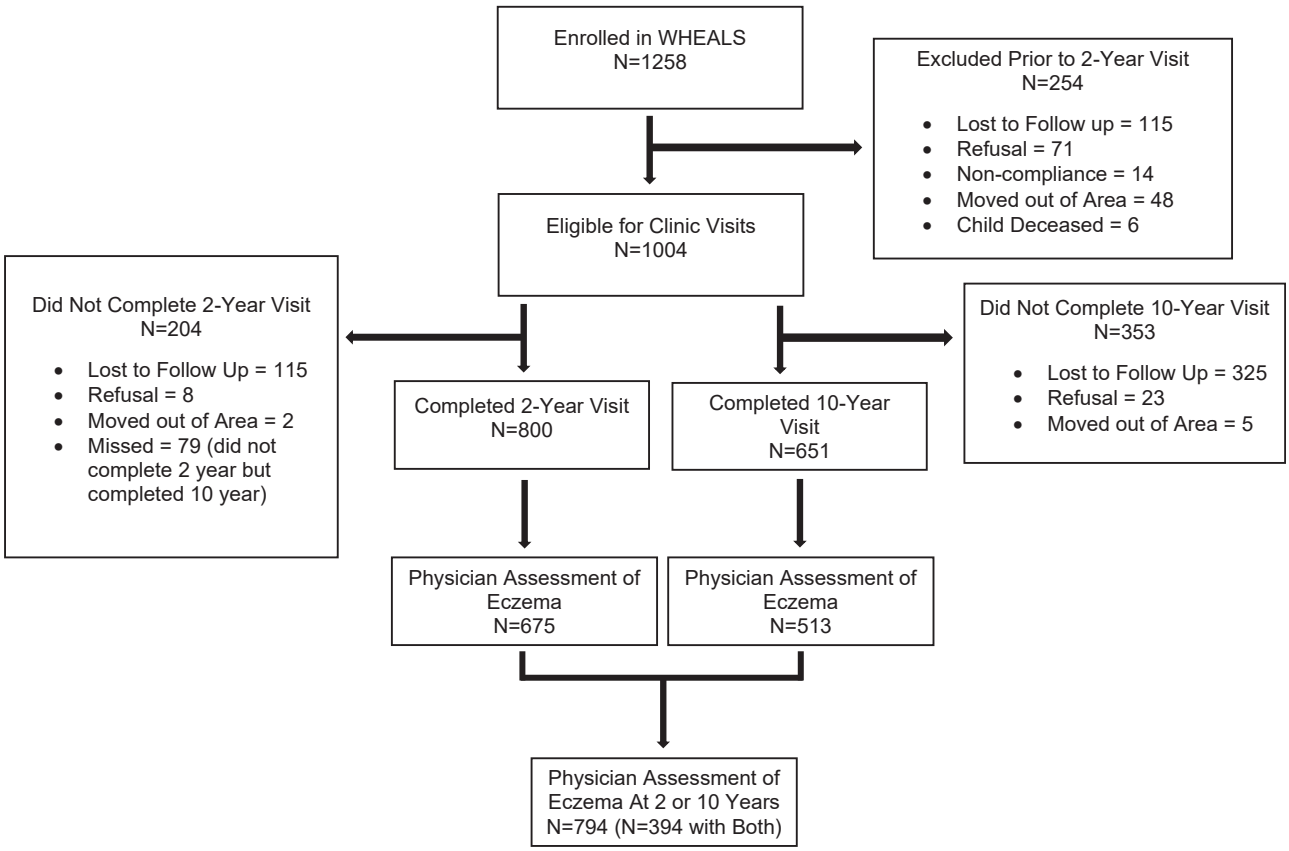

FIGURE E1. Wayne County Health, Environment, Allergy, and Asthma Longitudinal study (WHEALS) participation.