Prenatal Dog-Keeping Practices Vary by Race: Speculations on Implications for Disparities in Childhood Health and Disease

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Abstract

Objective—There is consistent evidence demonstrating that pet-keeping, particularly of dogs, is beneficial to human health. We explored relationships between maternal race and prenatal dog-keeping, accounting for measures of socioeconomic status that could affect the choice of owning a pet, in a demographically diverse, unselected birth cohort.

Design—Self-reported data on mothers' race, socioeconomic characteristics and dog-keeping practices were obtained during prenatal interviews and analyzed cross-sectionally. Robust methods of covariate balancing via propensity score analysis were utilized to examine if race (Black vs White), independent of other participant traits, influenced prenatal dog-keeping.

Setting—A birth cohort study conducted in a health care system in metropolitan Detroit, Michigan between September 2003 and November 2007.

Participants—1065 pregnant women (*n*=775 or 72.8% Black), between ages 21 and 45, receiving prenatal care.

Main Outcome Measures—Participant's self-report of race/ethnicity and prenatal dog-keeping, which was defined as her owning or caring for 1 dog for more than 1 week at her home since learning of her pregnancy, regardless of whether the dog was kept inside or outside of her home.

Results—In total, 294 women (27.6%) reported prenatal dog-keeping. Prenatal dog-keeping was significantly lower among Black women as compared to White women (20.9% vs 45.5%, *P*<. 001), and remained significantly different even after propensity score analysis was applied.

Conclusion—Findings suggest that there are persistent racial differences in dog-keeping not fully explained by measures of socioeconomic status. Racial differences in prenatal dog-keeping may contribute to childhood health disparities.

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Keywords

Racial Disparities; Pet-keeping; Dogs; Asthma; Allergy; Human-Animal Bond

Introduction

Keeping of pets, particularly dogs, appears to be associated with better overall human health.[1] Compared to persons who do not regularly reside with or care for dogs, dog owners, on average, have lower rates of cardiovascular disease, greater levels of physical activity, better mental health, and require fewer overall hospital and health care-related visits.[2,3] Positive benefits linked to this human-animal bond[1] appear to extend to health outcomes in early life. We and others[4–6] have previously shown that prenatal exposure to household pets or to farm livestock/animals is associated with lower offspring risk of allergic/asthmatic disease phenotypes. One plausible explanation for this reduced risk of sensitization may be related to dogs' influence on the home and human microbiomes.[7,8] Prior research has provided evidence that domestic pets, namely dogs and cats,[7,8] may increase the microbial diversity of home environments, thus broadening the array of microbe exposures among household family members. These diverse microbe exposures, in turn, may directly or indirectly promote immune tolerance to allergic sensitization in early life.[9]

Racial and ethnic disparities in rates of allergy and asthma are well-documented, with the prevalence of these conditions consistently estimated as being higher in US individuals of sub-Saharan African descent compared to those of European descent.[10,11] Reasons for these disparities have been attributed to biological, environmental and social factors including differences in physiology, air quality, education, and income.[12,13] Limited research has investigated how race or ethnicity, and other characteristics such as socioeconomic status (SES),[14,15] may be associated with pet-keeping, particularly in families expecting to have children. Understanding these relationships may facilitate better characterization and framing of social and environmental factors related to pet-keeping decisions. Such upstream factors related to the decision to keep a dog may be more closely associated with the risk of allergy or asthma in offspring than to the actual keeping of these pets. Further investigation of these complex factors is needed.

We examined racial differences in prenatal dog-keeping behavior in a racially and socioeconomically diverse cohort of pregnant women living in metropolitan Detroit, Michigan. We utilized a robust statistical technology – propensity score analysis[16,17] – to compare prenatal dog-keeping behaviors between Black and White study participants, allowing better estimation of the association between these variables in the context of unbalanced groups.

Methods

Study Protocol

Between September 2003 and November 2007, research staff of the Wayne County Health, Environment, Allergy, and Asthma Longitudinal Study (WHEALS) recruited pregnant women, aged 21–45, who were being treated by physicians in the Henry Ford Health System (HFHS) and living in metropolitan Detroit, into a longitudinal birth cohort study. Additional information on study design is available in earlier publications.[5,18] For our study, we utilized information collected from interviews conducted with pregnant women at a prenatal research visit. These interviews covered topics such as the pregnant woman's demographic traits, medical history, self-reported allergic symptomatology to pets, and recent pet-keeping

practices. Written consent was obtained from participants prior to enrollment in the study. The study protocol was approved by the HFHS Institutional Review Board.

The primary outcome of interest in this study was prenatal dog-keeping. Prenatal dog-keeping was defined as a pregnant woman's self-report of owning or caring for 1 dog for >1 week at her home since learning of her pregnancy, regardless of whether the dog was kept inside or outside of her home.[5,18] Keeping of other non-dog pets (eg, cats, birds) was defined as a pregnant woman's self-report of owning or caring for any non-dog pet for >1 week at her home since learning of her pregnancy, regardless of whether the non-dog pet was kept inside or outside the home. As done previously, an inside pet was defined as a pet that was kept inside of the home for at least 1 hour a day, on average.[19] Conversely, an outside pet was defined as a pet that was kept outside of the home for >23 hours a day, on average.[19] To address potential bias in reports of prenatal dog-keeping practices and associated health outcomes, women were queried regarding a variety of reasons why they intentionally might not keep pets, including health reasons such as allergy.[18]

Statistics

Univariable logistic regression models were fit to examine differences in participant characteristics by prenatal dog-keeping status. A multivariable logistic regression model was also fit to examine whether self-reported maternal race was associated with prenatal dog-keeping after covariate adjustment. There are known racial differences in a variety of socioeconomic factors that are also present in the WHEALS cohort;[10,20] this may create an imbalance when making comparisons by race, and may lead to biased effect estimates. Thus, propensity score modeling was used to add additional rigor to the analysis, by more completely accounting for this imbalance in covariates. We previously used propensity modeling for analysis of other outcomes in this cohort.[16] Briefly, for this analysis, we first estimated the propensity score (which here is the conditional probability of maternal race being White), given the following nine pre-specified self-reported covariates: 1) maternal age; 2) city residence (Detroit vs other); 3) maternal education; 4) annual household income; 5) marital status; 6) number of siblings (ie, mother's current child[ren]); 7) maternal prenatal smoking; 8) kept other non-dog pet; and 9) ever intentionally not kept pets due to someone living in her home being highly allergic to animals.

We then applied two approaches to utilize the propensity score: first, a doubly-robust approach that preserves the original sample size, and second, a more rigorous matching approach[5] that ensures closer balance between groups but reduces the analytic sample size. The doubly-robust logistic regression model adjusts the maternal race variable for both the propensity score plus each of the nine individual covariates utilized in the propensity score model. In the matching approach, we performed a one-to-one match of White mothers to Black mothers based on propensity score using a caliper of .2, which was the maximum allowable difference in propensity scores between the matched women.

We additionally conducted two sensitivity analyses. First, the keeping of dogs may only benefit human health through a microbial pathway if the dog is kept inside at least some time and at least occasionally is let outside.[5,18] We refit our final multivariable model examining the association of race with prenatal keeping of a predominantly inside dog only (excluding all dogs that were never kept inside). Second, residence type, which potentially provides insights on living space parameters limiting room for a dog at the home,[15] may also be associated with both maternal race and dog-keeping. Residence type (apartment vs other residence type) was assessed at an interview in the mother's home at approximately one month post-delivery by a trained field staff member. We refit our final models accounting for residence type among the 824 (77.4%) members of the cohort for whom we ascertained

residence type and whom were still living at the home address they provided during the prenatal interview. SAS V9.2 (Release 2, Cary, NC, USA) was utilized for all analyses.

Results

The final WHEALS cohort consisted of 1258 pregnant women. For the analysis, women who identified as Hispanic (*n*=81, 6.4%), Arabic (*n*=59, 4.7%), or other (*n*=53, 4.2%) were excluded, as dog-keeping practices may vary across these groups,[21] and we were underpowered to examine associations within these race/ethnicity categories. Thus, our final analytic sample included 1065 pregnant women self-identified as either Black (*n*=775, 72.8%) or White (*n*=290, 27.2%).

In contrast to the White women included in the analysis, Black women were, on average, statistically significantly younger in age, had less education, and were less likely to be married or to smoke during pregnancy (all *P*<.01) (data not shown).

Characteristics of Dog-Keeping Participants

Table 1 presents participant characteristics of those women who reported prenatal dog-keeping and those who did not. In total, 294 women (27.6%) reported prenatal dog-keeping. Those women keeping dogs were statistically significantly different from non-dog keeping women with respect to all selected covariates, except age, and were borderline statistically different for the variable of maternal prenatal smoking.

Statistically significant differences in rates of prenatal dog-keeping were observed by race, with more White women (*n*=132, 45.5%) than Black women (*n*=162, 20.9%) reporting owning   1 dog (unadjusted odds ratio [OR]=3.16, 95% CI: 2.37, 4.22, *P*<.001) (Table 2). After covariate adjustment, using either multivariable adjustment or propensity score methods, race remained statistically significantly associated with prenatal dog-keeping (Table 2).

In addition to race, in the fully-adjusted logistic regression model, only keeping of a non-dog pet (adjusted OR [aOR]=1.69, 95% CI: 1.23, 2.31) and ever intentionally not keeping pets due to someone living in their home being highly allergic to animals (aOR=.47, 95% CI: .30, .74) were statistically significantly associated with dog-keeping (both *P*=.001) (data not shown). All other covariates in the multivariable model were non-significant; maternal age (aOR=.99, 95% CI: .95, 1.02), city residence (aOR=1.47, 95% CI: 1.00, 2.17), maternal education (aOR=.90, 95% CI: .62, 1.31), annual household income (aOR=1.31, 95% CI: .81, 2.11), marital status (aOR=1.37, 95% CI: .97, 1.95), number of siblings (aOR=.90, 95% CI: .79, 1.03), and maternal prenatal smoking (aOR=1.39, 95% CI: .90, 2.13) were all not statistically significantly associated with prenatal dog-keeping in the fully-adjusted logistic regression model (all *P*>.05, data not shown).

We then explored whether there were any differences by race in the report of prenatal keeping of non-dog pets or of ever intentionally not keeping pets due to someone who lived in their home being highly allergic to animals. Consistent with the association of race with dog-keeping, the keeping of non-dog pets was significantly higher among White women (*n*=142, 49.0%) as compared to Black women (*n*=146, 18.8%) (*P*<.001). Marginally significantly more White women (*n*=53, 18.3%) than Black women (*n*=105, 13.6) reported ever intentionally not keeping pets due to someone who lives in their home being highly allergic to animals (*P*=.055).

Among the 294 women who reported prenatal dog-keeping, 28 (9.5%) were classified as having dogs that never came inside; all dogs defined as outside dogs spent all of their time

outside. Among dog-keepers, outside dogs were more commonly kept by Black women (*n*=24/162, 14.8%) than by White women (*n*=4/132, 3.0%) (*P*=.001). After excluding these 28 participants with outside dogs from the analysis, statistically significant relationships between dog-keeping and race persisted; (aOR=3.22, 95% CI: 2.10, 4.94, *P*<.001).

Of the 1065 women in the full analytic sample, a subgroup of 824 (77.4%) had information available on residence type (apartment vs other residence type). Of those women, a total of 89 (10.8%) were living in an apartment. Racial differences in residence type were observed, with significantly more Black women (81/575 or 14.1%) than White women (8/249 or 3.2%) residing in an apartment (*P*<.001). Lower levels of prenatal dog-keeping were observed among those residing in an apartment (8/89 or 9.0%) vs those not (232/735 or 31.6%) (*P*<.001). In this sub-sample, additionally adjusting for residence type, maternal race (White compared to Black) remained statistically significantly associated with prenatal dog-keeping; (aOR=2.64, 95% CI: 1.64, 4.25, *P*<.001).

Discussion

Data from this demographically diverse, unselected birth cohort showed that race was independently associated with prenatal dog-keeping, with dog-keeping rates among pregnant White women being more than double that of pregnant Black women. Although a growing number of studies have explored factors associated with pet-keeping,[15] to our knowledge, very few studies have specifically explored the relationships between dog-keeping and race in large, general risk populations.[14,22] Existing studies have examined pet-keeping in either highly-selected populations of asthmatics or older age groups.[14,23] Findings from these studies are consistent with ours in demonstrating strong racial differences in the keeping of dogs or other non-dog pets. In our study, the association between prenatal dog-keeping and race remained even after robust covariate adjustments were applied through propensity score analysis.

Reasons for the higher rates of prenatal dog-keeping among White women as compared to Black women are likely multifactorial. Previous research suggests that, in comparison to Black individuals, Whites individuals are, in general, more likely to experience human-animal-bonding and feel attached to animals, such as domesticated pets, and view them as companions.[24,25]

It is possible that historical usage of dogs to control and project hostility toward Blacks' ancestors during US slavery and more recently during the mid 20th century civil rights movement may contribute directly to modern-day Blacks' sentiments on dogs.[26,27] These culturally-inherited experiences may engender fearful or antagonistic views of dogs among some contemporary Blacks,[28,29] and cultivate avoidance tendencies. Moreover, in some communities, dogs are commonly kept for personal and home security purposes (ie, as watch or guard dogs),[30] and thus may be of a more aggressive variety, provoking intimidation in neighborhood residents. Elevated densities of unleashed or stray dogs in these communities may stir similar sentiments.[31,32] Cross culturally, similar attitudes and avoidant behaviors related to dogs may exist, where various ethnic groups and religious faiths may view these pets as violent, unhygienic or otherwise undesirable as domestic companions.[21,33] Accordingly, the lower levels of dog-keeping observed among certain populations may be best understood in the context of one's cultural experiences and preferences. Prior research suggests that social and health-related beliefs and behaviors in families and cultures may be transmitted and reproduced across multiple generations,[34,35] supporting this argument.

Another plausible factor explaining the racial differences in rates of dog-keeping observed here may be related to unmeasured time and costs associated with dog-keeping, which includes the resources needed to provide food, housing, recreational activities, and veterinary care. However, in our study, racial differences persisted even after adjusting for multiple measures of SES, though the extent to which our measured SES variables account for the all the resources needed to care for a dog are unknown.

Several limitations to our study exist. We did not have data addressing other potential factors associated with dog-keeping, such as convenient ground access,[15] housing restrictions against keeping pets on premises, fees for having pets in rented properties, or a participant's or a household member's fear or dislike of dogs for reasons unrelated to allergic disease. Results in our sub-sample of women with residence-related information revealed that residing in an apartment compared to other residence types somewhat attenuated the association between race and dog-keeping, although the association remained statistically significant. It is also possible that there are other variables influencing dog-keeping that we did not ascertain, such as participants possessing or adhering to philosophical, cultural or religious beliefs related to avoidance of dog-keeping, or participants feeling unsafe in some outdoor areas while walking or otherwise interacting with a dog. Future studies addressing specific sociocultural factors associated with the decision to keep a dog or not are warranted.

Despite the growing cache of research demonstrating the health benefits of dog-keeping, dog owners are also susceptible to a variety of health-related risks. Dogs may inflict lesions or abrasions through bites or scratches of owners that warrant hospitalization,[36,37] and in very rare instances, may transmit zoonotic diseases such campylobacteriosis and giardiasis, or rabies, which may be fatal.[1,37] Accordingly, uncertainty may develop in clinical practice regarding whether it is appropriate to advise patients, such as pregnant women, to keep or relinquish an existing pet, or to even acquire a new pet for the potential health benefits that may be reaped.[2,38,39] To that end, clinical recommendations around usage of dog-keeping as a protective health promotion exposure must be evaluated and weighed under the lens of the patient's current health status and preferences, as well as his or her culture and environment.[40]

Evidence continues to suggest that pet-keeping is associated with decreased risk of allergic diseases;[4–6] this is largely thought to be due to pets exposing children to a more diverse microbial environment and promoting proper immune system development.[41] In our study, African American women were less likely to have kept a pet and this could, in part, explain some of the racial disparities seen in allergy and asthma incidence.[10,20] In conclusion, results from this study indicate that an integral and complex personal characteristic, race, may be associated with an individual's decision to ultimately pursue, or avoid, dog-keeping. It is estimated that close to 40% of homes in the United States possess at least one dog,[42] but this summary statistic may mask the dog-keeping practices of large population subgroups. Differences in the rates of prenatal dog-keeping by race may be one factor contributing to the considerable disparities in measures of early-life health, including allergy and asthma.[10,20]

Acknowledgments

References

1. Rabinowitz P. Links among human health, animal health, and ecosystem health. Annu Rev Public Health. 2013; 34:189–204. [PubMed: 23330700]

2. Headey B. Health benefits and health cost savings due to pets: preliminary estimates from an Australian national survey. Soc Indic Res. 1999; 47(2):233–243.

3. Cutt H, Giles-Corti B, Knuiman M, et al. Dog ownership, health and physical activity: A critical review of the literature. Health Place. 2007; 13(1):261–272. [PubMed: 16503185]

4. Ege MJ, Herzum I, Büchele G, et al. Prenatal exposure to a farm environment modifies atopic sensitization at birth. J Allergy Clin Immunol. 2008; 122(2):407–12. 412.e1–4. [PubMed: 18678343]

5. Havstad S, Wegienka G, Zoratti EM, et al. Effect of prenatal indoor pet exposure on the trajectory of total IgE levels in early childhood. J Allergy Clin Immunol. 2011; 128(4):880–885.e4. [PubMed: 21820714]

6. Kerkhof M, Wijga A, Smit HA, et al. The effect of prenatal exposure on total IgE at birth and sensitization at twelve months and four years of age: the PIAMA study. Pediatr Allergy Immunol. 2005; 16(1):10–18. [PubMed: 15693906]

7. Fujimura KE, Johnson CC, Ownby DR, et al. Man's best friend? The effect of pet ownership on house dust microbial communities. J Allergy Clin Immunol. 2010; 126(2):410–412. 412.e1–3. [PubMed: 20633927]

8. Maier RM, Palmer MW, Andersen GL, et al. Environmental determinants of and impact on childhood asthma by the bacterial community in household dust. Appl Environ Microbiol. 2010; 76(8):2663–2667. [PubMed: 20154107]

9. Ege MJ, Mayer M, Normand AC, et al. Exposure to environmental microorganisms and childhood asthma. N Engl J Med. 2011; 364(8):701–709. [PubMed: 21345099]

10. Wegienka G, Havstad S, Joseph CLM, et al. Racial disparities in allergic outcomes in African Americans emerge as early as age 2 years. Clin Exp Allergy. 2012; 42(6):909–917. [PubMed: 22909162]

11. Akinbami LJ, Moorman JE, Liu X. Asthma prevalence, health care use, and mortality: United States, 2005–2009. Natl Health Stat Rep. 2011; (32):1–14.

12. Litonjua AA, Carey VJ, Weiss ST, et al. Race, socioeconomic factors, and area of residence are associated with asthma prevalence. Pediatr Pulmonol. 1999; 28(6):394–401. [PubMed: 10587412]

13. Weitzman M, Gortmaker S, Sobol A. Racial, social, and environmental risks for childhood asthma. Am J Dis Child. 1990; 144(11):1189–1194. [PubMed: 2239856]

14. Downes MJ, Roy A, McGinn TG, et al. Factors associated with furry pet ownership among patients with asthma. J Asthma. 2010; 47(7):742–749. [PubMed: 20684732]

15. Eller E, Roll S, Chen CM, et al. Meta-analysis of determinants for pet ownership in 12 European birth cohorts on asthma and allergies: a GA2LEN initiative. Allergy. 2008; 63(11):1491–1498. [PubMed: 18721248]

16. Havstad SL, Johnson CC, Zoratti EM, et al. Tobacco smoke exposure and allergic sensitization in children: a propensity score analysis. Respirology. 2012; 17(7):1068–1072. [PubMed: 22616936]

17. Schneider EC, Cleary PD, Zaslavsky AM, et al. Racial disparity in influenza vaccination: does managed care narrow the gap between African Americans and Whites? JAMA. 2001; 286(12):1455–1460. [PubMed: 11572737]

18. Aichbhaumik N, Zoratti E, Strickler R, et al. Prenatal exposure to household pets influences fetal immunoglobulin E production. Clin Exp Allergy. 2008; 38(11):1787–1794. [PubMed: 18702655]

19. Nicholas C, Wegienka G, Havstad S, et al. Dog characteristics and allergen levels in the home. Ann Allergy Asthma Immunol. 2010; 105(3):228–233. [PubMed: 20800790]

20. Wegienka G, Havstad S, Joseph CL, et al. Allergic sensitization frequency and wheezing differences in early life between Black and White children. Allergy Asthma Proc. 2012; 33(6):493–499. [PubMed: 23394507]

21. Blouin DD. Understanding relations between people and their pets. Sociol Compass. 2012; 6(11):856–69.

22. Schreiner P. *Characteristics of Pet Ownership in a Population-based Cohort: The Coronary Artery Risk Development in Young Adults (CARDIA) Study*. 45th Annual SER Meeting; Minneapolis, Minnesota, June 27–30, 2012. Am J Epidemiol. 2012; 175 (suppl 11):219. [abstract].

23. Gretebeck KA, Radius K, Black DR, et al. Dog ownership, functional ability, and walking in community-dwelling older adults. J Phys Act Health. 2013; 10(5):646–655. [PubMed: 23307529]

24. Brown SE. Ethnic variations in pet attachment among students at an American school of veterinary medicine. Soc Anim. 2002; 10(3):249–266.

25. Wolch, J.; Brownlow, A.; Lassiter, U. Animal Spaces, Beastly Places: New Geographies of Human-Animal Relations. London: Routledge; 2000. Constructing the Animal Worlds of Inner-city Los Angeles; p. 71-97.

26. Hunter C. Social control and dogs: a socio-historical analysis. Crime Delinq. 1994; 8(3):64–74.

27. Campbell A, Berk RA, Fyfe JJ. Deployment of violence: the Los Angeles Police Department's use of dogs. Eval Rev. 22(4):535–565.

28. Chapman LK, Vines L, Petrie J. Fear factors: cross validation of specific phobia domains in a community-based sample of African American adults. J Anxiety Disord. 2011; 25(4):539–544. [PubMed: 21315552]

29. Brown SE. The under-representation of African Americans in animal welfare fields in the United States. Anthrozoos. 2005; 18(2):98–121.

30. Kelling, GL.; Coles, CM. Fixing Broken Windows: Restoring Order and Reducing Crime in Our Communities. New York, NY: Free Press; 1996.

31. Wilson DK, Kirtland KA, Ainsworth BE, et al. Socioeconomic status and perceptions of access and safety for physical activity. Ann Behav Med. 2004; 28(1):20–8. [PubMed: 15249256]

32. Griffin SF, Wilson DK, Wilcox S, et al. Physical activity influences in a disadvantaged African American community and the communities' proposed solutions. Health Promot Pract. 2008; 9(2):180–190. [PubMed: 17728204]

33. Kenneth S, DeMello M. The State of Human–Animal Studies. Soc Anim. 2010; 18(3):307–318.

34. Allen ML, Elliott MN, Morales LS, et al. Adolescent participation in preventive health behaviors, physical activity, and nutrition: differences across immigrant generations for Asians and Latinos compared with Whites. Am J Public Health. 2007; 97(2):337–343. [PubMed: 17138919]

35. Williams DR, Neighbors HW, Jackson JS. Racial/ethnic discrimination and health: findings from community studies. Am J Public Health. 2003; 93(2):200–208. [PubMed: 12554570]

36. Gilchrist J, Sacks J, White D, et al. Dog bites: still a problem? Inj Prev. 2008; 14(5):296–301. [PubMed: 18836045]

37. Schalamon J, Ainoedhofer H, Singer G, et al. Analysis of dog bites in children who are younger than 17 years. Pediatrics. 2006; 117(3):e374–379. [PubMed: 16510617]

38. Chomel BB, Sun B. Zoonoses in the bedroom. Emerg Infect Dis. 2011; 17(2):167–172. [PubMed: 21291584]

39. Westgarth C, Heron J, Ness AR, et al. Family pet ownership during childhood: findings from a UK birth cohort and implications for public health research. Int J Environ Res Public Health. 2010; 7(10):3704–3729. [PubMed: 21139856]

40. Levine GN, Allen K, Braun LT, et al. Pet ownership and cardiovascular risk: a scientific statement from the American Heart Association. Circulation. 2013; 127(23):2353–2363. [PubMed: 23661721]

41. Azad MB, Konya T, Maughan H, et al. Infant gut microbiota and the hygiene hypothesis of allergic disease: impact of household pets and siblings on microbiota composition and diversity. Allergy Asthma Clin Immunol. 2013; 9(1):15. [PubMed: 23607879]

42. APPA National Pet Owners Survey 2011–2012. American Pet Products Manufacturers Association; americanpetproducts.org/pubs_survey.asp [Accessed March 30, 2013]

Table 1

Study participant characteristics by prenatal dog-keeping status, *N*=1065

| Prenatal Characteristics | Dog-Keeping at Prenatal Interview | | OR (95% CI)[a] | *P*[b] |
	Yes	No		
Number in group	294 (27.6)	771 (72.4)		
Maternal age, years, mean (SD)	30.8 (4.6)	29.0 (5.4)	1.01 (.98, 1.03)	.64
City residence, Detroit				
Yes	143 (23.5)	466 (76.5)	.62 (.47, .81)	.001
No	151 (33.1)	305 (66.9)		
Maternal education				
College degree	91 (32.9)	186 (67.1)	1.41 (1.05, 1.90)	.024
<College degree	203 (25.8)	585 (74.2)		
Annual household income				
<$40,000	86 (21.6)	313 (78.4)	-referent group-	
$40,000	173 (32.5)	360 (67.5)	1.75 (1.30, 2.36)	<.001
Refused/Don't Know	35 (26.3)	98 (73.7)	1.30 (.83, 2.05)	.26
Marital status				
Married	198 (32.0)	420 (68.0)	1.72 (1.30, 2.29)	<.001
Not Married	96 (21.5)	351 (78.5)		
Number of siblings, mean (SD)	1.0 (1.1)	1.2 (1.3)	.88 (.78, .99)	.028
Maternal prenatal smoking				
Yes	47 (34.6)	89 (65.4)	1.46 (.99, 2.14)	.053
No	247 (26.6)	682 (73.4)		
Kept other (non-dog) pet				
Yes	118 (41.0)	170 (59.0)	2.37 (1.78, 3.16)	<.001
No	176 (22.7)	601 (77.3)		
Ever intentionally not kept pets because someone living in their home is highly allergic to animals				
Yes	27 (17.1)	131 (82.9)	.50 (.32, .77)	.002
No	266 (29.4)	639 (70.6)		

Data are *n* (%) unless indicated otherwise.

[a]Unadjusted odds ratio (OR) and 95% confidence interval (CI).

[b]Comparing dog-keepers to non-dog-keepers.

Table 2

Association of maternal race with prenatal dog-keeping status, *N*=1065

| Maternal Race | Dog-Keeping at Prenatal Interview | | Logistic Regression | | Propensity Score Approach | |
	Yes n (%)	No n (%)	Unadjusted OR (95% CI)	Multivariable aOR (95% CI)[a]	Doubly-Robust aOR (95% CI)[a]	One-to-One Matching aOR (95% CI)[a]
White (*n*=290)	132 (45.5%)	158 (54.5%)	3.16 (2.37, 4.22)	3.08 (2.03, 4.68)	3.63 (2.34, 5.61)	3.45 (2.12, 5.62)
Black (*n*=775)	162 (20.9%)	613 (79.1%)	Referent	Referent	Referent	Referent

OR, unadjusted Odd Ratio; aOR, adjusted Odds Ratio; CI, confidence interval.

[a] Adjusted for the following covariates: (1) maternal age, (2) city residence (Detroit), (3) maternal education, (4) annual household income, (5) marital status, (6) number of siblings, (7) maternal prenatal smoking, (8) kept other non-dog pet, and (9) ever intentionally not kept pets because someone living in their home is highly allergic to animals.