Risk Factors Associated with Antibodies to Leptospires in Inner-city Residents of Baltimore: A Protective Role for Cats

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ABSTRACT

Leptospiral antibody prevalence was 16% in residents of Baltimore. Seropositivity was associated with age, gender, race, and bird ownership, and negatively associated with contact with rat excrement and cat ownership. Current cat ownership reduced the antibody risk associated with age and race from odds ratios (95% confidence interval) of 3.3 (2.0, 5.5) and 3.3 (1.1, 9.3), respectively, to the baseline level. These data establish the high prevalence of leptospiral antibody in Baltimore and suggest a protective role for cats in reducing the risk of human infection. (*Am J Public Health.* 1992;82:597–599)

Introduction

Leptospirosis is an acute, febrile spirochetal disease most commonly affecting the liver and kidneys. Although leptospirosis can be debilitating, infection frequently runs a milder or even asymptomatic course that may go undiagnosed.[1]

Leptospires (*Leptospira interrogans*) infecting humans are primarily maintained by warm-blooded vertebrates.[2] In cities, the Norway rat (*Rattus norvegicus*)[3–7] and dog[8] have been regarded as major reservoirs. The degree of human–animal contact with wild and domestic animals may be an important determinant of infection. In this paper we describe the prevalence of antibodies to leptospires in an inner-city population and examine risk factors associated with seropositivity.

Methods

Study Population

Sera and questionnaires were obtained from persons visiting a sexually transmitted disease clinic between March 1987 and December 1988, as described previously.[9,10] Subjects were primarily male (71.4%), Black (94.3%), and young (median age = 23.5 years); 99% lived within the city limits.[10]

Data Collection

Respondents signed informed consent forms and were individually interviewed. Verbal responses were recorded to questions of age; history of residence; yearly income; occupation; travel; frequency of rat and mouse sightings within current and past residences, on current or past streets and alleys, and at current or past work place; history of contact with rodents through trapping, excrement, handling animals, or receiving rodent bites; and current or past ownership or living with cats, dogs, or other pets (classified as mammal, bird, or amphibian/reptile/fish). Observed race and sex were noted. Blood from respondents was centrifuged and serum stored at −20°C.

Serology

Sera were screened for immunoglobulin G (IgG) by enzyme-linked immunosorbent assay (ELISA) using the serovar mwogolo, prepared by standard methods,[11] as antigen. Tests using this antigen are genus specific (R. R. Graham, unpublished data 1986). Sera reactive at 1:200 dilution were considered positive. A subsample of 37 sera positive by IgG ELISA were also tested by the microscopic agglutination test (MAT)[12] and screened for immunoglobulin M (IgM) by ELISA. Serogroups (serovars) used in MAT included Australis (*australis*), Autumnalis (*autumnalis*), Ballum (*ballum*), Bataviae (*bataviae*), Canicola (*canicola*), Grippotyphosa (*grippotyphosa*), Sejroe (*hardjo*), Icterohaemorrhagiae (*icterohaemorrhagiae, copenhageni*), Pomona (*pomona*), Pyrogenes (*pyrogenes*), Shermani (*shermani*), and Tarassovi (*tarassovi*). A MAT titer of 1:50 was considered positive for all serovars except *shermani*, where 1:800 was used because of the potential autoagglutination of the antigen.

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TABLE 1—Crude and Adjusted Odds Ratios for Variables Associated with Leptospiral Antibody in Baltimore, Md, 1987–1988

	Crude Odds Ratio (95% Confidence Interval)		Adjusted[a] Odds Ratio (95% Confidence Interval)	
Age (>19 vs ≤19)	2.3	(1.5, 3.5)	2.8	(1.8, 4.5)
Sex (male vs female)	1.5	(1.0, 1.9)	1.5	(1.0, 2.2)
Race (Black vs other)	1.8	(0.8, 3.9)	2.0	(0.9, 4.5)
Income (≤$8000 vs >$8000)	1.2	(0.8, 1.7)	1.6	(1.1, 2.4)
Contact with rat excrement (some vs none)	0.7	(0.5, 1.1)	0.5	(0.3, 0.9)
Current cat ownership (none vs ≥1)	2.1	(1.1, 3.8)	1.9	(1.1, 3.5)
Bird ownership (ever vs never)	1.4	(0.8, 2.5)	1.7	(1.0, 3.1)

[a]Adjusted for all other variables in table.

TABLE 2—Adjusted[a] Odds Ratios Associated with Age, Race, and Sex after Stratification by Current Cat Ownership

	Current Cat Ownership			
	None		One or More	
	Odds Ratio	95% Confidence Interval	Odds Ratio	95% Confidence Interval
Age (>19 vs ≤19)	3.3	2.0, 5.5	0.8	0.3, 2.8
Race (Black vs other)	3.3	1.1, 9.3	0.4	0.1, 1.6
Sex (male vs female)	1.5	1.0, 2.3	1.4	0.4, 1.6

[a]Adjusted for age, sex, race, income, contact with rat excrement, current cat ownership, and bird ownership.

All ELISA positive and 163 negative sera were tested for cross reactivity to *Treponema pallidum* by a standard rapid plasma reagin (RPR) assay.[13]

Data Analysis

Analyses were performed with SAS®[14] or BMDP®[15] software systems. Variables were dichotomized to ease interpretation of results and to allow calculation of odds ratios. Crude odds ratios were calculated for the association between all study variables and leptospiral serological status. Stratification and logistic regression were used to assess interactions between variables and to control for potential confounding variables.[16] Variables thought to be important a priori were included in initial logistic regression models, and the contribution of other variables was assessed by partial F tests. After selection of a model, all possible interactions between variables were assessed and retained if statistically significant ($P < .05$) or if felt to be biologically important.

Results

The prevalence of ELISA antibodies to leptospires was 16% (185/1150), with a single positive IgM titer found. Titers by MAT ≥1:50 to one or more serovars were found in 31 of 37 ELISA positive sera. The most common serotypes eliciting a response were Batavia (20/37) and Icterohaemorrhagiae (16/37). There was no indication of significant cross-reactivity with *T. pallidum* ($\chi^2 = 1.88$, $P = .17$).

Crude (unadjusted) analyses showed associations of leptospiral antibody with age and male gender, but not with other demographic variables. Current ownership of cats was significantly associated with lower antibody prevalence. None of the rodent exposure variables were associated with antibody.

Logistic regression indicated that age (≥19), sex (male), Black race, and low income (≤$8000) were independent risk factors associated with leptospiral antibody (Table 1). Self-reported contact with rat excrement was negatively associated with seropositivity.

History of bird ownership (chickens or pet birds) was positively associated, and cat ownership negatively associated, with antibody. An interesting interaction was observed between cat ownership and both age and race: Age and race were risk factors for seropositivity only in persons who did not own cats (Table 2).

Discussion

This study documented a high prevalence (16%) of leptospiral antibody in an inner-city population. Associations between antibody and age and sex were expected based on studies of leptospirosis in the United States.[17] However, the data also indicated a potential protective role for cat ownership in reducing the risk of infection.

Studies conducted in Detroit have also reported high levels of leptospiral antibody (≥30%) in inner-city children under 6 years old.[18] As in Baltimore, with three cases of leptospirosis documented since 1987 (R. Dunning, written communication 1991), disease was uncommon in Detroit. Leptospirosis is a self-limited condition with usual spontaneous recovery within 4 to 9 days.[19] Afflicted persons may not seek medical care, and the disease also is underreported.[19]

The serological tests we used indicated few recent infections. Specificity of our ELISA assay was indicated by the 84% concordance with MAT and lack of cross-reactivity with RPR tests. Other serosurveys have found that up to 35% of ELISA positive sera will not react by MAT.[20]

Risk of leptospirosis associated with animals has rarely been explored beyond incriminating a species during a case investigation or epidemic,[21,22] or stratification of human antibody prevalence based on animal contact.[23,24] We found a lowered risk of leptospiral antibody for persons reporting past history of exposure to rat excrement. This study variable may have measured rat awareness rather than "risky" behavior. The clearest and most interesting association was between decreased leptospiral seropositivity and cat ownership. Cats could reduce the risk of rodent-borne leptospirosis if they reduced human contact with the reservoir. The relationship between cat ownership and race is also interesting, as Blacks in Baltimore own fewer cats than do Whites.[25] This difference in cat ownership could place Black residents at increased risk for contact with rodents and the zoonoses

they carry, and could contribute to the increased prevalence of antibody in Black residents.

Cats have been linked to human infection with several pathogens (e.g., *Toxoplasma gondii*[26] and *Yersinia pestis*[27]), but, to our knowledge, never in a protective role. These novel observations deserve further research and confirmation by other studies. □

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