RECENT TRENDS OF CANINE LEPTOSPIROSIS IN THE UNITED STATES: SPATIAL, TEMPORAL, ENVIRONMENTAL AND ANIMAL-LEVEL RISK FACTORS

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INTRODUCTION

Leptospirosis is a reemerging zoonotic disease of concern that threatens companion animal and human health. Spread through the urine of infected animals, *Leptospira* spp. can infect dogs in a variety of settings across the United States. It produces a wide spectrum of clinical illness, with the possibility of death. Canine leptospirosis cases appear to be increasing in number in the United States, yet information on the epidemiology of the disease is lacking.

Hypothesis: Test-positive prevalence of canine leptospirosis is significantly influenced by environmental and animal factors.

Objectives:

- Describe the recent temporal and spatial distribution of canine leptospirosis in the United States.
- Identify environmental, seasonal, dog- and human-level factors associated with canine leptospirosis.

MATERIALS AND METHODS

Data acquisition:

- Dataset from IDEXX Laboratories of canine leptospirosis PCR tests submitted from January 2015 to December 2016 by US veterinary clinics. Data included veterinary clinic postal code, test date, dog breed, sex, date of birth, and test result. Data on environmental variables were acquired from publicly available databases.
- Extracted and cleaned data, removing duplicate entries (N=644) and coded missing data as appropriate.

Risk factor analysis:

- Univariable generalized mixed logistic regression models accounting for county and state to identify risk factors for a positive test. Variables with a p-value of <0.2 were eligible for the final model. A final multivariable generalized mixed logistic regression model accounting for county and state was built.

Data visualization:

- Calculated test-positive prevalence for each postal code, state, and region by year.
- Choropleth maps depicting test-positive prevalence by state and year.
- Line graphs to visualize regional and temporal changes in test-positive prevalence.

RESULTS

- 18,727 test entries and 14 variables were explored in association with a positive test outcome: season, breed group, sex, mean regional temperature and precipitation by month, state percent inland and overall water, estimated state dog density, urban influence code, income, education, and percent of state population that fishes and hunts.

Risk factor analysis:

- Five variables were statistically significant in univariable models (Table 1).
- The final multivariable model contained 3 variables: **female sex**, **dog age**, and **increased precipitation.** Odds ratios and 95% confidence intervals were similar to univariable results (Table 1).

Table 1: Significant variables identified in univariable generalized mixed logistic regression models predicting a positive canine leptospirosis test, accounting for county and state

Variable	Odds Ratio (95% CI)	p-value
Season		**<0.01**
Dec – Feb	Reference	
Mar – May	0.69 (0.56, 0.86)	<0.01
June – Aug	1.12 (0.93, 1.35)	0.229
Sept – Nov	1.38 (1.16, 1.65)	<0.01
Sex		**<0.01**
Male	Reference	
Female	0.77 (0.68, 0.88)	
Age (years)		**<0.01**
≤ 4	Reference	
5 – 7	0.72 (0.61, 0.85)	<0.01
8 – 10	0.45 (0.38, 0.54)	<0.01
≥ 11	0.26 (0.21, 0.33)	<0.01
Average regional temperature by month (°F)		**<0.01**
≤ 44	Reference	
45 – 58	1.50 (1.25, 1.82)	<0.01
59 – 70	1.11 (0.91, 1.35)	0.310
≥ 71	1.44 (1.18, 1.76)	<0.01
Average regional precipitation by month		**0.01**
< 4 inches	Reference	
≥ 4 inches	1.19 (1.03, 1.37)	

Data visualization:

- Overall test-positive prevalence across the United States was 5.5%; Texas (10% prevalence), Illinois (8.5%), Nebraska (8.2%), Iowa and West Virginia (each 8.1%) had the highest prevalence.
- In 2015 (Figure 1), the highest prevalence was found in the Midwest and South-central regions. Prevalence shifted in 2016 (Figure 2), with a noticeable increase in Arizona and Minnesota, and a decrease in the lower Midwest. Alaska and Hawaii are not pictured (no cases either year, except for 3.5% prevalence in Hawaii in 2016).
- Temporal and regional differences in test-positive prevalence were identified (Figure 3).

Figure 1: Canine leptospirosis test-positive prevalence across the United States in 2015

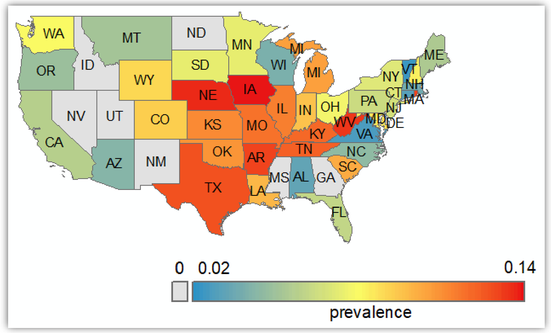


Figure 2: Canine leptospirosis test-positive prevalence across the United States in 2016

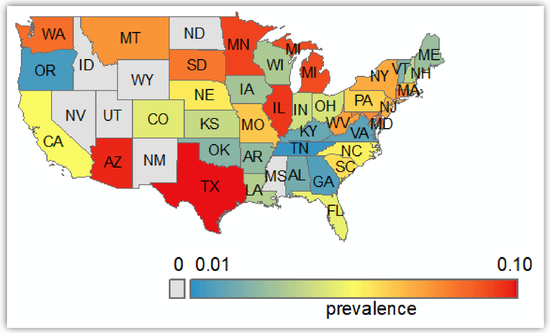
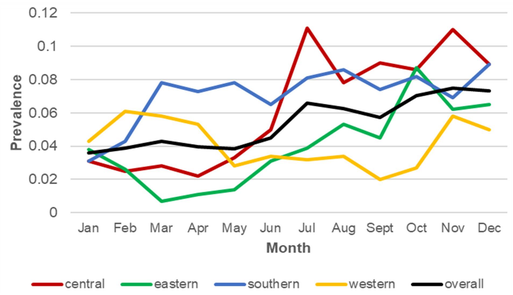


Figure 3: Temporal and regional canine leptospirosis test-positive prevalence for 2015 and 2016 combined



CONCLUSIONS

- This study utilized PCR test data (sensitivity: 92%, specificity: 99%).[1] Previous studies have commonly utilized MAT test data, which is less sensitive (sensitivity: 22% – 67%)[2] and vaccination can make MAT results difficult to interpret, thus our conclusions differ from previous studies.
- The Western, Midwest, and South-central regions have previously been identified as canine leptospirosis hot-spots.[3,4] In the current study, over both years, test-positive prevalence was highest in the Midwest and south-central regions; interestingly, the Western region was not identified as a high test-positive prevalence area.
- As identified previously, increased precipitation and temperatures were both significant predictors for a positive canine leptospirosis PCR test.[3]
- State-based prevalence varied between states and time (2015 vs. 2016). This illustrates how the distribution of cases can rapidly change over space and time.
- Only environmental and dog factors were implicated in the odds of a dog testing positive, aligning with our hypothesis. It is important to note that not all variables of interest were available for analysis due to limited information on each entry, and additional variables were limited to publicly available data.

Future Directions: Additional research is needed to investigate canine leptospirosis to identify modifiable risk factors (e.g., vaccination). Targeted education and prevention efforts at clients with dogs at risk are needed to decrease prevalence in the canine population and prevent possible transmission to humans. The spatial and temporal differences identified in this study can guide the location and timing of prevention campaigns.

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FURTHER INFORMATION

Disclosure: There is no conflict of interest related to this research.

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