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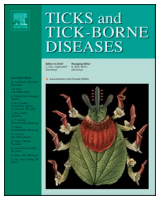

Short communication

Frequency of tick bites and associated care-seeking behaviors in the United States

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ABSTRACT

Tick-borne diseases are commonly reported in the United States, but frequency of tick bites and care-seeking behaviors following tick bites are poorly understood. We used nationally representative survey data to describe the frequency of tick bites among people living in the United States and how often, where, and why care-seeking associated with tick bites occurs. We found that over 31 million people (nearly 1 in 10) living in the United States might experience a tick bite each year and highlight regional trends in associated care-seeking behaviors. These findings emphasize the need for effective tick bite prevention education and regionally tailored healthcare provider recommendations for management of tick-borne diseases.

1. Introduction

Tick-borne diseases (TBDs) are the most common vector-borne infections in the United States. Risk of specific TBDs varies substantially by geographic region (Biggs et al., 2016; Dahlgren et al., 2015; Nichols Heitman et al., 2016; Schwartz et al., 2017; Swanson et al., 2023). In the Northeast, Mid-Atlantic, and Upper-Midwest where Lyme disease is most common, post-exposure prophylaxis (PEP) with a single dose of doxycycline (200 mg for adults or 4.4 mg/kg for children) is recommended to prevent Lyme disease following a bite from an *Ixodes* spp. tick that has been attached $\geq$ 36 h (Lantos et al., 2021). In a randomized trial, use of single dose of doxycycline as PEP was shown to significantly reduce the frequency of erythema migrans, the most frequent clinical manifestation of Lyme disease (Nadelman et al., 2001). PEP has not been evaluated for prevention of other bacterial TBDs (e.g., anaplasmosis) and would not be considered for prevention or treatment of parasitic or viral diseases (e.g., babesiosis or Powassan virus disease) less frequently transmitted by *Ixodes* spp. ticks.

Previous studies have identified significant gaps in public and healthcare provider knowledge regarding ticks and TBD distributions, as well as the appropriate use of PEP (Brett et al., 2014; Hook et al., 2015; Perea et al., 2015). To better inform educational efforts, we conducted a survey to quantify the frequency of tick bites and the associated reasons for care-seeking by region.

2. Materials and methods

ConsumerStyles is a set of nationally representative online surveys conducted annually by Porter Novelli that include questions on various health-related topics. Participants are drawn from a cohort of panelists, and surveys are performed in seasonal waves. Questions related to tick bites and associated care-seeking behaviors were included in the 2021 and 2023 FallStyles waves (Table 1). To match proportions observed in the U.S. Current Population Survey (CPS), data were weighted based on eight demographic variables, including gender, age, region, household income, race/ethnicity, education, metropolitan status, and household size.

We grouped states into three regions based on geography and incidence of Lyme and other TBDs ("North", "South", and "West"). The North region included 26 jurisdictions in the northeastern and upper-midwestern U.S. that have a high incidence of Lyme disease, defined as $\geq$ 10 confirmed cases per 100,000 population, or share a border with or are located between high-incidence states (Fig. 1). The South region included 12 states in the central and southeastern U.S. where ehrlichiosis, spotted fever rickettsioses, and the emerging tick bite-associated allergic condition, Alpha-gal syndrome, predominate (Fig. 1). The West region included 13 states in the western U.S., all with low incidence for TBDs (Fig. 1). We describe weighted proportions and 95 % confidence intervals (CI) for responses overall and by geographic region.

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Table 1
2021 and 2023 FallStyles tick-related survey questions and response options.

Question	Responses
1. "So far in 2021[2023]*, how many people in your household, including yourself, have found a tick attached to their body?"	*Insert number*
2. "Think about the last time a person in your household, including yourself, found a tick attached to their body. After noticing the attached tick, did that person seek healthcare?"	*Select one (If answered >0 to Question 1):* Yes; No; Don't know; Refused
3. "Where did the person with the attached tick seek healthcare?"	*Select one (If answered "Yes" to Question 2):* Emergency room/department; Urgent care or walk-in clinic; Primary care provider (including telehealth); Specialty healthcare provider; School nurse; Other healthcare setting not listed
4. "What were the reasons for seeking healthcare after finding the attached tick?"	*Select all that apply (If answered "Yes" to Question 2):* Tick removal; Antibiotic prescription to prevent Lyme disease; Laboratory testing; Other reasons not listed
5. "After removing the attached tick, did they take antibiotics to prevent Lyme disease?"	*Select one (If answered >0 to Question 1):* Yes; No; Don't know; Refused

* Survey responses were fielded during 9/24/2021–10/7/2021 and 9/1/2023–9/18/2023.

To estimate the number of people living in the United States who experience tick bites annually, we divided the average number of household members with tick bites by the average household size to determine the rate of tick bites per person; we extrapolated this rate to the 2022 U.S. population (U.S. Census Bureau, 2022). All analyses used SAS 9.4 (SAS Institute, Cary, NC).

3. Results

In total, there were 7083 responses to the tick-related questions. Most respondents (62.7 %) were White; 51.3 % were female; the median age was 47 years (range, 18–96); 48.1 % lived in the North region; 33.2 % had a bachelor's degree or higher; 45.9 % worked full-time; and 22.3 % had a household income ≥$150,000. The median household size was 2 (range, 1–10).

Overall, 14.3 % (CI: 13.3 %–15.2 %, Table 2) of respondents reported ≥1 individual in their household found a tick attached to their body in the previous year. Tick bites were most common among households in the North (19.1 %, CI: 17.6 %–20.6 %, Table 2), followed by the South (13.3 %, CI: 11.5 %–15.1 %) and West regions (5.7 %, CI: 4.4 %–7.0 %).

Among those who found an attached tick, 10.8 % (CI: 8.4 %–13.1 %) reportedly sought healthcare. This was more common in the North region (12.1 %, CI: 9.1 %–15.1 %) than in the South (9.1 %, CI: 4.0 %–14.2 %) and West (6.1 %, CI: 0.7 %–11.6 %). Respondents in the North most often visited a primary care provider (59.4 %, CI: 46.0 %–72.7 %), whereas respondents in the South most often visited emergency departments (43.7 %, CI: 11.8 %–75.6 %) and those in the West most often visited urgent care or walk-in clinics (68.1 %, CI: 26.1 %–100.0). The most common reasons for seeking healthcare were tick removal in the South (68.3 %, CI: 44.8 %–91.7 %]), and PEP for Lyme disease in the North and the West regions (64.9 % [CI: 51.7 %–78.2 %] and 91.3 % [CI: 73.6 %–100.0 %], respectively). Overall, 11.5 % (CI: 9.1 %–13.8 %) of those with tick bites reported taking PEP for Lyme disease. Taking PEP was more common among respondents from the North region (13.0 %, CI: 10.0 %–16.0 %), but not uncommon among respondents in the West and South (9.2 % [CI: 2.0 %–16.4 %] and 8.5 % [CI: 4.3 %–12.7 %], respectively]). Notably, response proportions were similar across both survey years.

We calculated that 0.094 (CI: 0.086–0.102) tick bites occurred per person, yielding a national estimate of 31,329,030 (CI: 28,662,730–33,995,331) people experiencing at least one tick bite per year. Applying the rate of care-seeking (10.8 %, CI: 8.4 %–13.1 %) to this estimate, we estimate 3,383,535 (CI: 2,631,639–4,104,203) healthcare visits for tick bites annually.

4. Discussion

Our findings indicate that over 31 million people living in the United States experience a tick bite each year, and roughly 3.4 million seek healthcare as a result. Tick bites are most common in regions with a high incidence of Lyme disease, a trend observed in previous studies (Hook et al., 2015; Nawrocki and Hinckley, 2021; Marx et al., 2021). Nevertheless, care-seeking following a tick bite occurs commonly throughout the country, with regional variation in the type of healthcare setting and the reasons for seeking care.

Recommendations for Lyme disease PEP apply to individuals living in or traveling to high-risk areas (Lantos et al., 2021). Still, approximately 9 % of respondents in low incidence regions reported taking PEP for a tick bite. While we were unable to assess travel history,

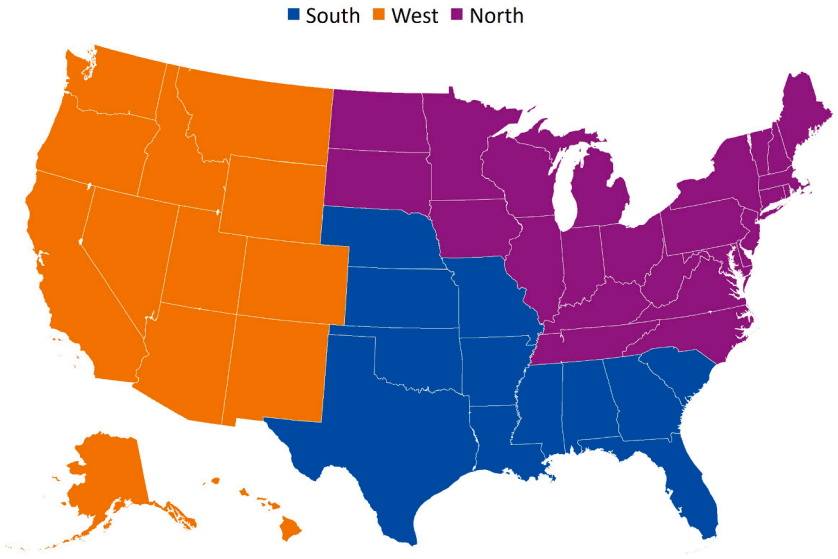

Fig. 1. U.S. states grouped based on similarity of tick-borne disease incidence and the distribution of common pathogen carrying ticks.

Table 2
Frequency of reported tick bites and associated care-seeking behaviors by region.

	North*		South†		West‡		Total	
No. of people in household who found a tick on their body	**Unweighted Frequency**	**Weighted % (95 % CI)§**	**Unweighted Frequency**	**Weighted % (95 % CI)§**	**Unweighted Frequency**	**Weighted % (95 % CI)§**	**Unweighted Frequency**	**Weighted % (95 % CI)§**
None	2761	77.8 (76.2 – 79.4)	1601	83.9 (82.0 – 85.9)	1511	91.4 (89.8 – 93.0)	5873	82.7 (81.7 – 83.8)
One or more	685	19.1 (17.6 – 20.6)	247	13.3 (11.5 – 15.1)	95	5.7 (4.4 – 7.0)	1027	14.3 (13.3 – 15.2)
Refused to answer	54	1.9 (1.3 – 2.5)	26	1.7 (1.0 – 2.4)	28	2.1 (1.2 – 2.9)	108	1.9 (1.5 – 2.3)
Removed	44	1.2 (0.8 – 1.6)	20	1.1 (0.6 – 1.7)	11	0.8 (0.3 – 1.4)	75	1.1 (0.8 – 1.4)
Sought health care after finding an attached tick								
Yes	79	12.1 (9.1 – 15.1)	17	9.1 (4.0 – 14.2)	6	6.1 (0.7 – 11.6)	102	10.8 (8.4 – 13.1)
No	578	83.7 (80.3 – 87.1)	217	85.6 (79.9 – 91.3)	65	69.5 (58.9 – 80.1)	860	82.8 (79.9 – 85.6)
Don't know	28	4.2 (2.3 – 6.1)	13	5.3 (2.2 – 8.4)	23	24.4 (14.5 – 34.2)	64	6.4 (4.6 – 8.2)
Type of healthcare facility visited after finding attached tick								
Emergency department	6	15.5 (3.9 – 27.1)	4	43.7 (11.8 – 75.6)	0	0.0 (0.0 – 0.0)	10	21.0 (8.7 – 33.2)
Urgent care/Walk-in clinic	11	14.6 (5.5 – 23.7)	5	26.8 (3.1 – 50.5)	4	68.1 (26.1 – 100.0)	20	20.2 (11.1 – 29.4)
Primary care provider	53	59.4 (46.0 – 72.7)	6	22.0 (2.7 – 41.4)	2	31.9 (0.0 – 73.9)	61	49.6 (37.6 – 61.6)
Specialty provider	2	1.7 (0.0 – 4.2)	1	3.4 (0.0 – 10.1)	0	0.0 (0.0 – 0.0)	3	2.0 (0.0 – 4.3)
School nurse	0	0.0 (0.0 – 0.0)	0	0.0 (0.0 – 0.0)	0	0.0 (0.0 – 0.0)	0	(0.0 – 0.0)
Other healthcare setting	7	8.8 (1.5 – 16.0)	1	4.1 (0.0 – 12.3)	0	0.0 (0.0 – 0.0)	8	7.2 (1.6 – 12.9)
Reasons for seeking healthcare								
Tick removal	15	30.6 (16.4 – 44.7)	8	68.3 (44.8 – 91.7)	2	48.2 (1.5 – 95.0)	25	39.9 (27.1 – 52.7)
Antibiotic prescription	54	64.9 (51.7 – 78.2)	7	39.1 (10.7 – 67.5)	5	91.3 (73.6 – 100.0)	66	60.7 (48.4 – 72.9)
Laboratory testing	16	16.1 (7.6 – 24.8)	3	23.2 (0.0 – 48.8)	2	56.7 (1.0 – 99.9)	21	20.0 (10.7 – 29.2)
Other reasons not listed	13	14.8 (6.5 – 23.1)	6	19.6 (2.1 – 37.2)	2	19.9 (0.0 – 48.6)	21	16.1 (8.9 – 23.4)
Took antibiotics after tick removal to prevent LD								
Yes	86	13.0 (10.0 – 16.0)	19	8.5 (4.3 – 12.7)	7	9.2 (2.0 – 16.4)	112	11.5 (9.1 – 13.8)
No	553	79.3 (75.6 – 83.1)	204	80.8 (75.1 – 86.6)	61	63.2 (52.1 – 74.4)	818	78.2 (75.1 – 81.3)
Don't know	42	7.1 (4.5 – 9.8)	24	10.7 (6.2 – 15.1)	25	25.6 (15.7 – 35.4)	91	9.8 (7.5 – 12.1)
Refused	4	0.6 (0.0 – 1.1)	0	0.0 (0.0 – 0.0)	2	2.0 (0.0 – 4.7)	6	0.5 (0.1 – 1.0)

* The North region includes 26 jurisdictions (25 states and the District of Columbia) in the Northeast and Upper-Midwest U.S. that have a high incidence of Lyme disease, defined as ≥ 10 confirmed cases per 100,000 population, or share a border with or are located between high-incidence states.
† The South region includes 12 states in the central and southeastern U.S. where ehrlichiosis, spotted fever rickettsioses, and Alpha-gal syndrome predominate.
‡ The West region includes 13 states in the western U.S. with low incidence for tick-borne diseases.
§ Response proportions displayed in the table are weighted to U.S. Census estimates for demographic variables, including gender, age, region, household, income, race/ethnicity, education, metropolitan status, and household size.

non-recommended use of PEP by providers in areas with low Lyme disease risk has been documented previously (Brett et al., 2014; Perea et al., 2015). Receiving PEP for Lyme disease in low incidence regions can contribute to overtreatment (Reid et al., 1998; Warshafsky et al., 2010) or could delay treatment for other TBDs (e.g., Rocky Mountain spotted fever) (Kenyon et al., 1978), highlighting a continued need for improved healthcare provider education about when PEP for Lyme disease is appropriate.

Tick removal is typically a simple process that does not require healthcare expertise. However, our findings suggest that many people seek care for tick removal, particularly in regions with low incidence for TBDs. Healthcare visits solely for tick removal may be of limited value with respect to diagnosing and treating TBDs. Typically, it can take 3–30 days for symptoms of common TBDs to occur following a tick bite, and testing conducted without apparent clinical illness is likely to yield negative results. Additionally, delaying tick removal to seek assistance from a healthcare provider could put individuals at increased risk for pathogen transmission from the tick. To prevent potentially unnecessary healthcare visits and delayed tick removal, public health education should have an increased focus on encouraging timely self-removal of

attached ticks alongside information about monitoring for TBD symptoms.

We observed geographic differences in care-seeking for tick bites that may be driven by several factors. For example, compared to states in the North and West regions, access to primary healthcare in the South is more limited, which has been associated with more common care-seeking at emergency facilities (Coster et al., 2017; Streeter et al., 2020). This may partially explain the predominance of care-seeking at emergency facilities in the South region. Additionally, the type of healthcare facility visited might reflect different perceptions of TBD severity. Individuals with frequent exposure to ticks might have a lower perceived risk of the health effects from a single tick bite (Slunge and Boman, 2018).

Limitations of this study include small sample sizes for analyses of geographic differences in care-seeking, potential recall bias, and responses being collected before the end of the calendar year. In addition, more respondents reported taking PEP than reported seeking care, which may reflect prescription through other services (e.g., telehealth).

Tick bites and care-seeking following tick bites are both common in the United States. These findings highlight the need for effective tick bite prevention education nationwide, as well as tailored information related to regional TBD risk and associated recommendations for seeking healthcare and healthcare provider use of PEP.

Disclaimer

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

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CRediT authorship contribution statement

Austin R. Earley: Writing – original draft, Methodology, Formal analysis, Data curation, Conceptualization. **Kiersten J. Kugeler:** Writing – review & editing, Supervision, Methodology, Conceptualization. **Paul S. Mead:** Writing – review & editing, Investigation, Conceptualization. **Alison F. Hinckley:** Writing – review & editing, Writing – original draft, Supervision, Methodology, Conceptualization.

Declaration of competing interest

The authors declare no conflicts of interest.

Data availability

Data will be made available on request.

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