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Knowledge, attitudes, and behaviors regarding tick-borne disease prevention in endemic areas

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Abstract

As part of a TickNET collaboration we evaluated the knowledge, attitudes, and behaviors related to tick-borne disease (TBD) prevention among persons living in endemic areas of Connecticut (CT) and Maryland (MD). Up-to-date information on the use of various prevention methods, as well as attitudes toward available and potential prevention options, is critical for effective promotion of recommended behaviors.

During 2016–2017, printed invitations were mailed via the post office to 27,029 households requesting participation in an online survey regarding knowledge of TBD, risk perceptions, and prevention behaviors. Prevention behaviors included tick checks, showering/bathing, insect repellents, pet tick control, and chemical or natural pesticide use on residential properties. Associations of sociodemographic characteristics and knowledge and attitude variables with prevention behaviors were assessed in unadjusted analyses and multivariable models to calculate adjusted odds ratios (aOR). Participants were also asked if they would be willing to get a Lyme disease (LD) vaccine, if one becomes available.

Overall, 1883 (7%) persons completed the survey. Participants reported using preventive behaviors most of the time or always as follows: pet tick control (83%), tick checks (58%), showering/bathing (42%), insect repellent (31%), and chemical (23%) or natural (15%) pesticides on property. Self-rated knowledge of LD, perceived prevalence of LD, perceived severity of LD, and perceived likelihood of contracting LD or another TBD were significantly ($p < 0.05$) associated with performing a tick check [aOR 2.5, aOR 1.71, aOR 1.36, aOR 1.83, respectively]. Female gender and perceived prevalence of LD were significantly associated with applying insect repellent [aOR 1.56, aOR 1.64, respectively]. Perceived prevalence of LD was significantly associated with

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Declaration of Competing Interest

None.

Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.ttbdis.2019.07.008.

showering or bathing, insect repellents, and pet tick control [aOR 1.42, aOR 1.64, aOR 1.92, respectively]. Income ≥ $100,000 was significantly associated with applying a chemical or natural pesticide to one's property [aOR 1.29, aOR 1.40, respectively]. A majority of respondents (84%) reported that they were very likely or somewhat likely to get a LD vaccine if one were available.

Few behaviors (tick checks and pet tick control) were reported to be practiced by more than half of the respondents living in LD endemic areas. Perceived prevalence of LD was the only factor associated with performing most of the prevention behaviors (tick checks, showering/bathing, use of insect repellents, and pet tick control). Use of chemical or natural pesticides appears to be driven by income. Greater efforts are needed to encourage use of prevention behaviors in endemic areas, and this may be facilitated by increasing awareness of local prevalence.

Keywords

Tick-borne disease prevention; Tick-borne disease knowledge; Tick-borne disease behavior; Tick-borne disease attitudes; Tick-borne diseases; Ticks

1. Introduction

Tick-borne diseases (TBD), especially Lyme disease (LD), represent a significant public health concern in the Northeast, mid-Atlantic, and Upper Midwest United States. From 2008–2015, an annual average of 34,450 confirmed and probable cases of LD were reported to the Centers for Disease Control and Prevention (CDC) (Schwartz et al., 2017). However, CDC estimates that the actual number of LD cases are underreported by as much as 90%, placing the true burden closer to 330,000 cases per year (Nelson et al., 2015). Other previously recognized tick-borne diseases that can be acquired through a tick bite in these geographic areas are babesiosis, anaplasmosis, Powassan virus disease, tularemia, ehrlichiosis, and spotted fever rickettsiosis (Centers for Disease Control and Prevention, 2018). In addition, several new tick-borne pathogens have recently been discovered in these areas of the United States including *Borrelia miyamotoi* (Krause and Barbour, 2015).

Methods of TBD prevention include personal protective behaviors that minimize the risk of tick or pathogen exposure, yard modifications or acaricidal treatments that aim to control tick populations on property, and community approaches such as treating deer or landscaping public parks (Curran et al., 1993; Dolan et al., 2004; Hinckley et al., 2016; Pound et al., 2009; Schulze et al., 1994; Stafford, 2007). Personal protective behaviors such as checking for ticks, using insect repellent, and bathing after spending time in or near tick habitat are relatively simple and inexpensive measures. Though some studies have shown effectiveness of these measures (Connally et al., 2009), conflicting evidence exists and effectiveness relies on consistency of practice (Corapi et al., 2007; Vazquez et al., 2008). A vaccine against LD was available in the US in 1998 but has not been available since 2002 when the manufacturer stopped production and withdrew it from the market (Poland, 2011; Shen et al., 2011; Aronowitz, 2012). New vaccines are currently being tested in Europe and the United States (Comstedt et al., 2017; Valneva, 2019).

Residential property treatments, another recommended approach to LD prevention in the United States, have been shown to reduce tick abundance but have not yet been shown to reduce tick-borne disease in humans (Hinckley et al., 2016). Though property-based controls do not require daily use like the personal protective behaviors, they tend to be expensive if used regularly for optimal tick control and may be cost-prohibitive to many homeowners. People may also be less likely to use residential property treatments due to concerns for the environment (Aenishaenslin et al., 2016). Finally, property-based controls target disease that would be acquired peridomestically so personal protective measures are still needed when away from home.

The acceptance and implementation of any prevention measure can be influenced by a person's knowledge and attitude regarding their risk of contracting a TBD. For most of the personal and property-based prevention methods available, current data do not exist on the knowledge, perceptions or use of these methods (Gould et al., 2008). Research from more than a decade ago in Connecticut (CT) indicated a high frequency of personal protective behaviors and substantial concern about LD, but the association between perceptions and behaviors was not assessed (Gould, et al., 2008). A more recent study from 2015 of a nationally representative survey of the U.S. population indicated that the use of most personal and property prevention methods are low in the New England and Mid-Atlantic regions (Hook et al., 2015). However, limited information currently exists for individuals who live in areas highly endemic for LD. Up-to-date information on this population's use of various prevention methods as well as attitudes toward the prevention methods is critical for effective promotion of impactful methods.

The purpose of this study was to assess knowledge, attitudes, and behaviors regarding personal protective behaviors and property-based prevention methods to prevent TBDs among persons living in LD endemic areas of CT and Maryland (MD). These findings may be used to shape prevention messaging, prioritize which prevention methods should be further evaluated for acceptability and effectiveness, and target the promotion of prevention methods that could yield substantial reductions in TBD incidence.

2. Materials and methods

This cross-sectional survey was conducted in select areas of CT and MD. These two states used slightly different approaches to recruitment based on what was deemed locally feasible. In CT, recruitment efforts targeted the three towns with the highest number of reported LD cases in each of the five highest incidence counties (Fairfield, Hartford, Middlesex, New Haven, and New London) in 2015. A random sample of residential addresses was chosen from each of these fifteen towns to receive invitations to complete the survey. In MD, a random sample of residential addresses was chosen from three counties with a high incidence of LD (Anne Arundel, Harford, and Howard counties) to receive invitations. Addresses were obtained from SalesGenie/Infogroup, a commercial marketing database company. In order to obtain a list of addresses that aligned with our eligibility criteria it was necessary to purchase them through a marketing company that had the required information. The company provided us with a random sample of addresses that met the eligibility criteria, including age of resident and homeownership (vs. rental). Salesgenie compiles their address

lists from a variety of sources including directories, real estate databases, voter registration files, and utility connections and thus included the necessary information. Their database does not include all existing addresses in the state.

The survey was administered in two waves. The first wave that completed the survey during late August through early November 2016 consisted of home-owning adults (≥ 18 years of age) living in free-standing houses with a surrounding yard of at least a half acre who also had internet access. Because of a low response rate for the first wave (3.9%), the inclusion criteria for the second wave were broadened by eliminating the requirements of property ownership and size of yard. The second wave was conducted from late May through July 2017.

Participants were recruited via mailed printed invitations. In CT, 4000 invitations were mailed in 2016 and 5058 invitations were mailed in 2017. In MD, 12,000 invitations were mailed in 2016 and 5971 invitations were mailed in 2017. Respondents were only contacted via mailed invitations one time.

Participants were invited to complete a web-based survey (see Appendix 1 for sample survey items) expected to take less than 20 min. The survey was administered using the Research Electronic Data Capture software (REDCap). First, respondents answered questions about their age, yard size, and whether they could make decisions regarding their property in order to verify that they were eligible to complete the survey. Eligible respondents were then asked a combination of yes/no, multiple choice, and open ended questions. The survey was based on previously implemented surveys in CT (Connally et al., 2009; Gould et al., 2008) and was pre-tested with a small group of people. Minor edits were made to the survey based on feedback received. Predictor variables collected were: demographics of the participating household member, history of TBD among household members, and self-rated knowledge and attitudes regarding TBD. Dependent variables collected related to the use of protective behaviors against tick bites and TBDs that were likely to be used by household residents in the peridomestic setting. While other, non-peridomestic interventions, such as treating deer or landscaping in public areas, may be important interventions, our survey focused on the behaviors most feasible to implement in a peridomestic setting. Participants were also asked their likelihood of getting a LD vaccine if one were available. Respondents indicated their consent by checking a box stating that they were willing to take the survey. The protocol for this study was reviewed and approved by ethics committees at CDC, Yale University, the CT Department of Public Health, and the MD Department of Health. After completion of the survey, participants were mailed a $10 gift card to a local store.

Chi-square tests were performed to compare CT and MD data. Logistic regression modeling was used to analyze the association between dependent variables (personal protective behaviors, property-based protective behaviors and vaccine acceptability) and predictor variables including demographics, self-reported knowledge and attitudes regarding LD, and history of a TBD diagnosis. Measures were dichotomized for logistic regression modeling to increase statistical power and facilitate interpretation of results as relative effects for one group compared to another group. All adjusted models controlled for state of residence. Variables that were associated with the outcomes in unadjusted models at $p > .20$ were

excluded from the multivariable logistic regression using backward stepwise selection until all variables retained in the adjusted model were significant at $p < .05$. All analyses were performed using SPSS Version 24 (Armonk, New York) and SAS 9.4 (Cary, North Carolina).

3. Results

3.1. Sample characteristics

A total of 1883 adult respondents (7%) completed the survey (Table 1). The majority of participants were older than 50 years of age (70%), had at least a college or graduate school education (87%), had a household income of greater than $100,000 per year (53%), and were male (54%). The majority of respondents rated themselves as having some or a lot (80%) of knowledge of LD, and they perceived the prevalence of LD as common or very common (63%) and the severity of LD as very severe (62%). Self-rated knowledge of anaplasmosis, babesiosis, ehrlichiosis, and Rocky Mountain spotted fever was limited (little or no knowledge: 80%–94%). Only 8% perceived the likelihood of contracting a TBD next year as very likely. Slightly more than one-quarter (28%) of respondents reported previous diagnosis with a tick-borne disease.

3.2. Frequency of prevention behaviors

Slightly more than half of respondents reported that they performed a tick check on themselves most of the time or always (58%), and slightly less than half reported showering or bathing after spending time outdoors (42%) or applying insect repellent (31%) most of the time or always. The majority of respondents did use tick control products on their pet (83%), while a minority reported applying a chemical pesticide (23%) or natural pesticide (15%) to their yard. The following prevention behaviors were implemented sometimes, most of the time, or always: worn permethrin treated clothing (7%), used bait boxes for tick control through the treatment of rodents with acaricide (17%) and had a deer fences (16%). Because these variables were implemented infrequently they were excluded from further analyses. A majority of respondents (84%) reported that they were either somewhat (35%) or very (49%) likely to get a LD vaccine if one were available.

3.3. Correlates of personal protective behaviors

The unadjusted and adjusted analyses of the personal protective behaviors are presented in Table 2. In the unadjusted analyses of the personal protective behaviors the following variables were significantly associated with performing a tick check on oneself: education level, self-rated knowledge of LD, perceived prevalence of LD, perceived severity of LD, perceived likelihood of contracting a TBD in the next year, ever being diagnosed with a TBD, and state of residence. Showering or bathing after spending time outside was significantly associated with perceived prevalence of LD and perceived severity of LD. Applying insect repellent to oneself was significantly associated with income level, sex, perceived prevalence of LD, and perceived likelihood of contracting a TBD next year. For those who reported owning pets, applying tick control products to one’s pet was significantly associated with income level, self-rated knowledge of LD, and perceived prevalence of LD.

In analyses that were adjusted for other significant covariates and state, performing a tick check on oneself was negatively associated with higher education level (aOR = .63, 95% CI = .45–.87) and positively associated with higher self-rated knowledge of LD (aOR = 2.5, 95% CI = 1.89–3.31), higher perceived prevalence of LD (aOR = 1.71, 95% CI = 1.37–2.13), higher perceived severity of LD (aOR = 1.36, 95% CI = 1.1–1.67), and higher perceived likelihood of contracting a TBD in the next year (aOR = 1.83, 95% CI = 1.2–2.78). Showering or bathing after spending time outside was positively associated with higher perceived prevalence of LD (aOR = 1.42, 95% CI = 1.15–1.74) and higher perceived severity of LD (aOR = 1.28, 95% CI = 1.05–1.56). Applying insect repellent to oneself was negatively associated with higher income (aOR = .65, 95% CI = .53–.81), but positively associated with female sex (aOR = 1.56, 95% CI = 1.26–1.94) and higher perceived prevalence of LD (aOR = 1.64, 95% = 1.3–2.08). Applying tick control products to one's pet was positively associated with higher income (aOR = 1.71, 95% CI = 1.21–2.42) and higher perceived prevalence of LD (aOR = 1.92, 95% CI = 1.35–2.73).

3.4. Correlates of property treatment behaviors

In Table 3, the unadjusted and adjusted analyses of property treatments are shown. Applying a chemical pesticide to one's yard was significantly associated with higher income level and being diagnosed with a TBD in unadjusted analysis. Applying a natural pesticide to one's yard was significantly associated with higher income level and female sex.

In the analysis adjusted for other significant covariates and state, applying a chemical pesticide to one's yard remained positively associated with higher income level (aOR = 1.29, 95% CI = 1.01–1.65) and applying a natural pesticide to one's yard remained positively associated with higher income level (aOR = 1.40, 95% CI = 1.05–1.88) and female sex (aOR = 1.43, 95% CI = 1.08–1.91).

3.5. Willingness to receive a vaccine

We also examined the unadjusted and adjusted analyses of the willingness to get a LD vaccine if one were available. In the unadjusted analysis the willingness to get a LD vaccine was significantly associated with higher self-rated knowledge of LD, perceived higher prevalence of LD, perceived higher likelihood of contracting a TBD in the next year, and ever being diagnosed with a TBD. After adjusting for other significant covariates and state, the willingness to get a LD vaccine, if one were available, remained positively associated with higher self-rated knowledge of LD (aOR = 1.66, 95% CI = 1.21–2.26), perceived higher prevalence of LD (aOR = 1.59, 95% CI = 1.2–2.1), and ever being diagnosed with a TBD (aOR = 1.55, 95% CI = 1.1–2.18).

3.6. State characteristics

There were some statistically significant differences between respondents from the two states. CT respondents were more likely to be female and had a higher education level than MD respondents. CT respondents had higher self-rated knowledge of LD, had a higher perceived prevalence of LD, and had a higher perceived likelihood of contracting a TBD in the next year. More CT respondents also reported being diagnosed with a TBD in the past.

While the CT and MD results are presented in aggregate, the state of residence was included in the multivariable analyses to account for these differences.

4. Discussion

The two most commonly practiced prevention behaviors were performing tick checks, which was reported by slightly more than half of the respondents, and applying tick control to pets, which was reported by a majority of respondents who were pet owners. Other behaviors were reported less often, including showering or bathing after spending time outdoors, applying insect repellent to oneself, and applying a pesticide to one's yard (chemical or natural). These results are similar to another CT study where researchers determined that the most commonly reported behavior was performing a tick check while the least likely reported behavior was the use of insect repellent (Butler et al., 2016). Similar results were found in a Canadian study where respondents reported performing regular tick checks (52%) and showering or bathing (41%). Also in the Canadian study, 41% of respondents reported using insect repellent, while in our study 31% of respondents reported using insect repellent (Aenishaenslin et al., 2017). Our study differed from a study conducted in the Netherlands where respondents reported conducting tick checks 32% of the time and wearing insect repellent 6% of the time compared to 58% and 31% of the time in our study respectively (Beaujean et al., 2013). Despite decades of education about some of these measures, especially tick checks and applying insect repellent to oneself, consistent use of these prevention behaviors remains suboptimal for residents of endemic areas in the United States. This finding suggests that research efforts need to focus on barriers to the use of the behaviors and strategies to overcome these challenges. In particular, showering or bathing after spending time outdoors has been shown to be protective against LD, and this behavior could be more actively promoted (Connally et al., 2009).

There was a striking difference between the frequency of applying tick/insect repellent to oneself compared to pets. Most of the respondents who were pet owners applied tick control to their pets, but only a minority of respondents applied insect repellent to themselves on a regular basis. It is possible that people felt that tick checks (which 58% of the respondents reported doing most of the time or always) were sufficient for tick control for themselves, or that they dislike applying a chemical to their body or their child's body. It is also possible that respondents felt that their pets were more likely than they were to encounter ticks while outside. It also could be that pet owners value flea prevention more than tick prevention and use available products that protect pets against both. Furthermore, the high frequency of application needed for humans (daily when in tick habitat) could be a deterrent compared to the lower frequency needed for pets (typically once per month). It should be noted that the insect repellent question and pet tick control question consisted of different answer scales. The answer options for the insect repellent question were always, most of the time, sometimes, rarely, and never, while the pet tick control answer options were yes, no, or I do not have a pet that goes outdoors. Nevertheless, a better understanding of the barriers to the use of insect repellant by persons in endemic areas could guide future prevention messages and interventions.

Perceiving LD as common or very common was associated with being more likely to perform all of the personal protective behaviors. Thus, raising awareness about local levels of LD may promote greater use of prevention measures. In contrast, the perceived likelihood of contracting a TBD in the next year was only associated with one protective behavior (performing a tick check). Furthermore, being previously diagnosed with a TBD was not associated with any of the personal protective behaviors or property-based prevention behaviors. It is unclear from the present analysis why perception of LD as common is associated with performing prevention behaviors, but perception of risk to self or history of diagnosis is not. It is possible that respondents had performed these protective behaviors before contracting a tick-borne disease, leading to a belief that they are not effective. Better understanding of the complex relationship between knowledge, perceived risk, and behavior is necessary for the prevention of LD.

Self-rating one's knowledge of LD as "some" or "a lot" was associated with being more likely to perform a tick check on oneself but was not associated with any of the other personal protection behaviors. These findings are similar to the findings in another CT study where researchers found that those who had higher knowledge scores were more likely to perform tick checks but not the other preventive behaviors. One important difference between these studies was that we asked respondents to self-rate their knowledge, while the other study's researchers asked the respondents general LD knowledge questions to create a knowledge score (Butler et al., 2016). Canadian researchers also found that having a high level of LD knowledge was associated with performing prevention behaviors. Similar to Butler's CT study, the Canadian researchers asked specific knowledge questions of the respondents (Aenishaenslin et al., 2017). Researchers in the Netherlands similarly found that higher levels of knowledge were associated with performing a tick check but, unlike our study, they created a knowledge score for respondents based on aggregated answers to selected questions (Beaujean et al., 2013).

Individuals with lower education levels were more likely to perform a tick check than those with higher education levels. Individuals with lower education may be more likely to have jobs that require outside work, for example landscaping or yard maintenance, leading to the need to perform tick checks more often. Those with a higher education level and incomes may choose other more expensive options such as property measures, including use of lawn treatments (as was observed in this study) and/or landscaping options. Similarly, individuals reporting lower income levels were more likely to apply insect repellent to themselves than those with higher incomes. It may be that individuals who have treated their yards feel personal insect repellent is unnecessary. Alternatively, people who are less likely to use insect repellent may choose to spray their yard. The protection afforded by this approach is limited to time spent on one's property and does not apply to time spent in tick habitat off of one's property. It may also reflect different opinions about the acceptability of insect repellent use.

While there is currently no LD vaccine available for humans, it is encouraging that if one were available, the vast majority (84%) of respondents reported that they would be very or somewhat likely to get the vaccine. Reporting a higher level of knowledge of LD, believing that LD is common or very common, and being previously diagnosed with a tick-borne

disease were factors associated with being more likely to getting a LD vaccine. As vaccine development continues, further research into reasons for hesitancy are necessary to prepare for optimal uptake in high incidence areas.

Demographic differences were found when comparing participants in the two states, including sex and education level, as well as differences regarding self-rated knowledge and perceived prevalence of LD, perceived likelihood of contracting a TBD in the next year, ever being diagnosed with a TBD, and how often one performed a tick check on oneself. These differences may be due to the earlier emergence of Lyme disease in CT as compared to MD. Nevertheless, in the multivariable analyses, MD residents were more likely than CT residents to practice the behavior of showering or bathing after spending time outdoors.

Our findings are subject to several limitations. Data collected in this survey were self-reported and, therefore, may be subject to poor recall. Furthermore, respondents self-reported their level of knowledge rather than having it directly measured. The tick check procedure was not defined in the survey instrument, therefore respondents were able to interpret a tick check as they chose. Also, given the low response rate, there is a potential for selection bias due to non-response if, for example, those with higher concern about LD and greater likelihood of practicing LD prevention were more likely to respond. Thus, these findings could overestimate the frequency of adoption of preventive behaviors, though it is difficult to assess because we did not gather information on non-respondents, including those who were not eligible or did not complete the survey.

The proportion of survey respondents who were female and older than 50 years was larger than the 2010 census population proportions (35% of CT's population and 32% of MD's population are ≥ 50 years; both states' populations are 51% female), suggesting our findings may not represent the general population in the sampled jurisdictions, limiting generalizability. In addition, there was no option to complete the surveys over the phone so it is possible that there was an underrepresentation of older or lower income residents in the survey population. Further, we do not know whether the addresses purchased from the Salesgenie/Infogroup were representative of the general population. Also, due to different sampling strategies between CT and MD, there may be limited comparability between the two states for some questions. Lastly, this survey was only conducted in select areas of CT and MD, so findings may not be generalizable to other endemic regions within, or beyond, CT and MD.

5. Conclusions

Of the prevention behaviors, only tick checks and pet tick control were reported by more than half of the respondents. Perceived high prevalence of LD was the only factor associated with performing four prevention behaviors: checking for ticks, showering or bathing, using insect repellents and applying pet tick control products. Use of chemical or natural pesticides appears to be driven by income, and those with higher income were less likely to practice personal prevention behaviors. The vast majority of respondents reported that they would be willing to get a LD vaccine if one were available to them. Greater efforts are needed to encourage use of prevention behaviors in endemic areas, and this could be

facilitated by increasing awareness of local LD prevalence. Also, more research needs to be done regarding people's willingness to practice these prevention behaviors, including getting a LD vaccine, and the factors that may encourage, or discourage, practicing these personal prevention behaviors.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1

Characteristics of Study Population by State, Connecticut and Maryland, 2016–2017.

	n (%)			
	CT (n = 624)	MD (n = 1259)	Total (n = 1883)	p values
Age				
≥50	420 (67%)	893 (71%)	1313 (70%)	.107
18-49	204 (33%)	366 (29%)	570 (30%)	
Education				
College/Grad School	557 (90%)	1071 (86%)	1628 (87%)	.014
Elementary/Middle/High School	65 (11%)	182 (15%)	247 (13%)	
Income				
≥$100,000	284 (51%)	599 54%)	883 (53%)	.280
< $100,000	268 (49%)	505 (46%)	773 (47%)	
Sex				
Female	347 (56%)	519 (41%)	866 (46%)	< .001
Male	275 (44%)	738 (59%)	1013 (54%)	
Self-rated knowledge of LD				
Some/A lot	546 (88%)	947 (76%)	1493 (80%)	< .001
None/A little	76 (12%)	306 (24%)	382 (20%)	
Perceived prevalence of LD				
Common/Very Common	490 (80%)	649 (54%)	1139 (63%)	< .001
Rare/Somewhat Common	121 (20%)	547 (46%)	668 (37%)	
Perceived severity of LD				
Very Severe	375 (61%)	779 (63%)	1154 (62%)	.326
Not/Moderately Severe	243 (39%)	457 (37%)	700 (38%)	
Perceived likelihood of contracting TBD next year				
Very Likely	64 (11%)	75 (7%)	139 (8%)	< .001
Unlikely/Moderately Likely	519 (89%)	1081 (94%)	1600 (92%)	
Ever been diagnosed with TBD				
Yes	259 (42%)	262 (21%)	521 (28%)	< .001
No	365 (59%)	997 (79%)	1362 (72%)	
Performing a tick check on oneself				
Most of the time/Always	387 (62%)	694 (55%)	1081 (58%)	.005
Never/Rarely/Sometimes	237 (38%)	563 (45%)	800 (43%)	
Showering or bathing after spending time outdoors				
Most of the time/Always	249 (40%)	545 (43%)	794 (42%)	.157
Never/Rarely/Sometimes	375 (60%)	713 (57%)	1088 (58%)	
Applying insect repellent to oneself				
Most of the time/Always	191 (31%)	387 (31%)	578 (31%)	.937
Never/Rarely/Sometimes	433 (69%)	870 (69%)	1303 (69%)	
Applying tick control to pet				
Yes	319 (86%)	574 (81%)	893 (83%)	.058

	n (%)			
	CT (n = 624)	**MD (n = 1259)**	**Total (n = 1883)**	**p values**
No	52 (14%)	131 (19%)	183 (17%)	
Applying chemical pesticide to yard				
Yes	118 (21%)	275 (24%)	393 (23%)	.119
No	452 (79%)	868 (76%)	1320 (77%)	
Applying natural pesticide to yard				
Yes	76 (14%)	170 (16%)	246 (15%)	.314
No	464 (86%)	893 (84%)	1357 (85%)	
Likelihood of getting a LD vaccine if available				
Very/Somewhat Likely	538 (86%)	1044 (83%)	1582 (84%)	.082
Very/Somewhat Unlikely	85 (14%)	210 (17%)	295 (16%)	

Table 2

Unadjusted and Adjusted Odds Ratios for Practicing Personal Protection Behaviors Most of the Time or Always by Demographics, Knowledge, Attitudes, and History of Tickborne Disease, Connecticut and Maryland, 2016–2017.

	Performing tick check on oneself (n = 1881)			Showering or bathing after spending time outdoors (n = 1882)			Applying insect repellent to oneself (n = 1881)			Applying tick control to pet (n = 1076)		
	%	uOR (95% CI)	aOR (95% CI)	%	uOR (95% CI)	aOR (95% CI)	%	uOR (95% CI)	aOR (95% CI)	%	uOR (95% CI)	aOR (95% CI)
Age												
≥50	59%	1.18 * (.97-1.44)		42%	1.00 (.82-1.21)		30%	.94 (.76-1.16)		83%	1.04 (.74-1.47)	
18-49	55%			42%			32%			83%		
Education												
College/ Grad School	57%	.73 ** (.55-.96)	.63 ** (.45-.87)	42%	.98 (.75-1.29)		31%	1.11 (.83-1.50)		84%	1.47 * (.96-2.26)	
Elementary/ Middle/ High School	64%			43%			29%			78%		
Income												
≥$100,000	57%	1.05(.86-1.27)		41%	.92(.75-1.11)		27%	.66 + (.54-.81)	,65 + (.53-.81)	86%	1.82 + (1.30-2.56)	1.71 + (1.21-2.42)
< $100,000	56%			43%			36%			78%		
Sex												
Female	59%	1.11(.92-1.33)		43%	1.09(.91-1.32)		37%	1.67 + (1.37-2.04)	1.56 + (1.26-1.94)	84%	1.18(.86-1.63)	
Male	56%			41%			26%			82%		
Self-rated knowledge of LD												
Some/A lot	62%	2.78 + (2.21-3.51)	2.50 + (l.89-3.31)	43%	1.21 * (.96-1.52)		32%	1.28 (.99-1.64)		85%	1.77 + (1.20-2.61)	
None/A little	37%			39%			27%			75%		
Perceived prevalence of LD												
Common/ Very Common	65%	2.22 + (1.83-2.71)	1.71 + (1.37-2.13)	45%	1.36 + (1.12-1.66)	1.42 + (1.15-1.74)	34%	1.56 + (1.26-1.93)	1.64 + (1.30-2.08)	86%	1.89 + (1.36-2.64)	1.92 + (1.35-2.73)

	Performing tick check on oneself (n = 1881)			Showering or bathing after spending time outdoors (n = 1882)			Applying insect repellent to oneself (n = 1881)			Applying tick control to pet (n = 1076)		
	%	uOR (95% CI)	aOR (95% CI)	%	uOR (95% CI)	aOR (95% CI)	%	uOR (95% CI)	aOR (95% CI)	%	uOR (95% CI)	aOR (95% CI)
Rare/ Somewhat Common	46%			37%			25%			77%		
Perceived severity of LD												
Very Severe	62%	1.59 $^{+}$(1.32-1.93)	1.36 **(1.10-1.67)	45%	1.38 $^{+}$(1.14-1.67)	1.28 **(1.05-1.56)	32%	1.16 *(.94-1.42)		84%	1.11(.80-1.55)	
Not/ Moderately Severe	51%			37%			29%			82%		
Perceived likelihood of contracting TBD next year												
Very Likely	77%	2.66 $^{+}$(1.77-3.99)	1.83 **(1.20-2.78)	47%	1.25(.88-1.77)		39%	1.48 **(1.04-2.12)		87%	1.38(.72-2.66)	
Unlikely/ Moderately Likely	56%			41%			30%			83%		
Ever been diagnosed with TBD												
Yes	66%	1.66 $^{+}$ (1.35-2.05)		45%	1.14 (.93-1.40)		31%	.99 (.79-1.23)		84%	1.08 (.76-1.54)	
No	54%			41%			31%			83%		
State												
Connecticut	62%	1.33 $^{+}$ (1.09-1.61)		40%	.87 *(.72-1.1)	.78 **(.63-.96)	31%	.99 (.81-1.2)		86%	1.4 *(.99-2.0)	
Maryland	55%			43%			31%			81%		

uOR: unadjusted odds ratio; aOR: adjusted odds ratio.

Adjusted models controlled for significant covariates and state.

* p value < .20

** p value < .05

$^{+}$ p value < .01

$^{\#}$ Other category of values was “Never, Rarely, Sometimes”.

Table 3

Unadjusted and Adjusted Odds Ratios for Use of Chemical or Natural Pesticide Treatments by Demographics, Knowledge, Attitudes, and History of Tickborne Disease, Connecticut and Maryland, 2016–2017.

	Applying chemical pesticide to yard (n = 1713)			Applying natural pesticide to yard (n = 1603)		
	%	uOR (95% CI)	aOR (95% CI)	%	uOR (95% CI)	aOR (95% CI)
Age						
≥50	22%	.86 (.67-1.10)		15%	.83 (.61-1.12)	
18-49	25%			17%		
Education						
College/Grad School	24%	1.39 * (.96-1.99)		16%	1.23 (.80-1.89)	
Elementary/Middle/High School	18%			13%		
Income						
≥$100,000	25%	1.29 ** (1.01-1.65)	1.29 ** (1.01-1.65)	18%	1.37 ** (1.03-1.84)	1.40 ** (1.05-1.88)
< $100,000	20%			14%		
Sex						
Female	22%	.87 (.70-1.10)		18%	1.45 ** (1.10-1.90)	1.43 ** (1.08-1.91)
Male	24%			13%		
Self-rated knowledge of LD						
Some/A lot	24%	1.20 (.89-1.62)		15%	.93 (.66-1.31)	
None/A little	20%			16%		
Perceived prevalence of LD						
Common/Very Common	24%	1.01 (.80-1.28)		15%	.94 (.70-1.24)	
Rare/Somewhat Common	23%			16%		
Perceived severity of LD						
Very Severe	22%	.92 (.73-1.17)		16%	1.05 (.79-1.39)	
Not/Moderately Severe	24%			15%		
Perceived likelihood of contracting TBD next year						
Very Likely	20%	.82 (.52-1.28)		18%	1.20 (.74-1.95)	
Unlikely/Moderately Likely	23%			16%		
Ever been diagnosed with TBD						
Yes	19%	.75 ** (.58-.97)		15%	1.01 (.75-1.36)	

	Applying chemical pesticide to yard (n = 1713)			Applying natural pesticide to yard (n = 1603)		
	%	uOR (95% CI)	aOR (95% CI)	%	uOR (95% CI)	aOR (95% CI)
No	24%			15%		
State						
Connecticut	21%	.83* (.65-1.1)		14%	.86 (.64-1.2)	
Maryland	24%			16%		

uOR: unadjusted odds ratio; aOR: adjusted odds ratio.

Adjusted models controlled for significant covariates and state.

* p value < .20.

** p value < .05

+ p value < .01.