Willingness to Pay for Select Tick-Borne Disease Prevention Measures in Endemic Areas

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ABSTRACT

Tick-borne diseases (TBDs) are increasing despite prevention recommendations. We explored whether cost is a barrier to prevention use in Connecticut and Maryland, using a cross-sectional survey. Respondents were queried regarding their willingness to pay for chemical, natural, and rodent-targeted yard pesticide treatments and permethrin-treated clothing. We evaluated associations between demographics, TBD knowledge and attitudes, and willingness to pay for prevention methods.

Most respondents would pay for yard treatments (85%); 95% preferring natural pesticide, and 82% would pay for permethrin-treated clothing. Most did not want to pay more than $99 for any of the yard treatments. Having a household income of $100 000 was associated with willingness to pay $100 or more for chemical, natural, or rodent-targeted treatments and $25 or more for permethrin self-treated and pretreated clothing. Yard treatments, especially natural pesticides, were acceptable for TBD prevention; however, current pricing may be cost-prohibitive. Permethrin-treated clothing may be an affordable and acceptable prevention method.

KEY WORDS: Lyme disease, permethrin, tick-borne disease, ticks

Tick-borne diseases (TBDs), such as Lyme disease (LD), represent a substantial public health concern in the Northeast, mid-Atlantic, and Upper Midwest United States.[1] More than 30 000 cases of LD are reported to the Centers for Disease Control and Prevention (CDC) yearly.[2] However, because of underreporting, the estimated number may be 10-fold higher.[3] In 2018, the number of confirmed cases reported to the CDC by Connecticut and Maryland was 1268 and 894, respectively (CDC.gov, October 2020).

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Recommended TBD prevention includes personal protective behaviors and environmental controls. Personal protective behaviors include tick checks, using insect repellent, bathing after spending time in tick habitat, and wearing pesticide-treated clothing.[4,5] These are relatively simple and inexpensive measures; however, they must be used consistently. Environmental controls include area-wide and host-targeted pesticide applications[6-8]; these require less frequent use but can be expensive if used regularly for optimal tick control. Factors influencing the use of these prevention measures include risk perception, level of effort required, and cost,[9-13] though few studies have explored willingness to pay (WTP) for prevention.[14]

In this study, we sought to understand factors associated with WTP for select TBD prevention options.

Methods

We conducted a cross-sectional survey to assess knowledge, attitudes, and behaviors regarding TBD prevention among adults living in LD endemic areas of Connecticut and Maryland, with methods described previously.[15] Briefly, respondents were invited to complete a 10- to 20-minute Web-based survey during 2016-2017. We obtained addresses for persons residing in freestanding homes from SalesGenie/Infogroup, a marketing database company. We mailed

invitations to a random sample of addresses from select areas in Connecticut and Maryland. Outcome variables included WTP $0, $1-$99, $100-$299, $300-$499, $500-$1000, or more than $1000 per year for chemical, natural, and rodent-targeted pesticide treatments of one's yard and WTP $0, $1-$24, $25-$49, $50-$74, $75-$100, or more than $100 for permethrin-treated clothing (PTC). We also asked respondents which method of clothing treatment they preferred (treating their own clothing at home; purchasing new, pretreated clothing; or sending their own clothing to a company for treatment). Independent variables included demographics, history of TBD among household members, and self-rated TBD knowledge, attitudes, and behaviors.

We used logistic regression modeling to analyze the association between outcomes and independent variables. We dichotomized WTP outcomes in order to increase statistical power and facilitate interpretation of results. All variables associated with the outcomes in unadjusted models were included in the multivariable logistic regression model. Variables with $P > .20$ were removed using backward stepwise selection until all variables retained in the model were statistically significant at $P < .05$. We performed analyses using SPSS version 24 (Armonk, New York) and SAS 9.4 (Cary, North Carolina). Respondents indicated consent by checking a box at the beginning of the survey. The study protocol was granted an exemption by the Yale University Institutional Review Board (protocol #1604017551) and approved by the Connecticut Department of Public Health Human Investigation Committee (protocol #848) and the Institutional Review Boards at the Maryland Department of Health (protocol #16-22) and the CDC (protocol #6878).

Results

Of 27 029 invitations mailed, 1883 (7%) respondents completed the survey. Most respondents were older than 50 years (70%), male (54%), had at least a college education (87%), and reported household incomes of $50 000 to $200 000 (74%).

More than three-fourths (85%) of respondents would pay for yard treatment. Of these, 95% would pay for natural pesticide, 72% would pay for rodent-targeted treatment, and 63% would pay for chemical pesticide. Of those who would pay for natural pesticide, 3% would pay $500 or more while the majority (63%) would pay $1 to $99. Of those who would pay for rodent-targeted treatment, 2% would pay $500 or more while the majority (76%) would pay $1 to $99. Of those who would pay for chemical pesticide, 4% would pay $500 or more while the majority (66%) would pay $1 to $99.

Prior to this survey, 74% of respondents had not heard of PTC and 84% had never worn it. Eighty-two percent of respondents would pay for PTC. Of these, 92% would pay for self-treatment, 82% would pay for purchasing pretreated clothing, and 50% would pay to send their clothes for professional treatment. Of those who would pay for self-treatment, 8% would pay $75 or more while the majority (59%) would pay $1 to $24. Of those who would pay for purchasing pretreated clothing, 20% would pay $75 or more while the plurality (33%) would pay $1 to $24. Of those who would pay for sending their own clothes for professional treatment, 10% would pay $75 or more while the plurality (47%) would pay $1 to $24.

In adjusted analyses of WTP for yard treatments (Table 1), having an income of $100 000 or more was positively associated with WTP $100 or more for chemical (adjusted odds ratio [aOR] = 2.76; 95% CI, 1.96-3.89), natural (aOR = 2.70; 95% CI, 2.08-3.48), or rodent-targeted (aOR = 3.17; 95% CI, 2.18-4.59) treatment. Females were more willing to pay $100 or more for chemical (aOR = 1.55; 95% CI, 1.12-2.14), natural (aOR = 1.52; 95% CI, 1.19-1.95), or rodent-targeted (aOR = 1.59; 95% CI, 1.15-2.21) treatment. A higher perceived prevalence of LD was associated with WTP $100 or more for chemical pesticide treatment (aOR = 1.86; 95% CI, 1.30-2.66). Residing in Connecticut was associated with WTP $100 or more for chemical (aOR = 1.51; 95% CI, 1.10-2.13) or natural (aOR = 1.71; 95% CI, 1.33-2.22) treatment.

In adjusted analyses of WTP for PTC (Table 2), having an income of $100 000 or more was associated with WTP $25 or more for self-treated (aOR = 1.44; 95% CI, 1.14-1.81) and purchased pretreated (aOR = 1.62; 95% CI, 1.24-2.12) clothing. Having a higher self-rated knowledge of LD was associated with WTP $25 or more for self-treated (aOR = 1.86; 95% CI, 1.36-2.52) and purchased pretreated (aOR = 58; 95% CI, 1.12-2.22) clothing. A higher perceived prevalence of LD was associated with WTP for purchased pretreated clothing (aOR = 1.35; 95% CI, 1.01-1.79), and being female was inversely associated with WTP for sending one's clothes for professional treatment (aOR = 0.65; 95% CI, 0.48-0.88).

Discussion

Most respondents were willing to pay for yard treatment but not more than $99. Respondents were most willing to pay for natural pesticide, followed by rodent-targeted treatments, and, finally, chemical pesticide. Women and those with an income of $100 000 or more were significantly more likely to be willing to pay $100 or more for any yard treatment, while Connecticut residents were more likely to be willing to

TABLE 1

Unadjusted and Adjusted Odds Ratios for 1883 Respondents Willing to Pay $100 or More for Chemical, Natural, or Rodent Pesticide Treatments by Demographics, Knowledge, Attitudes, and History of Tick-Borne Disease, Connecticut and Maryland, 2016-2017[a]

	WTP ≥$100 for Chemical Pesticide on Property (n = 296)			WTP ≥$100 for Natural Pesticide on Property (n = 507)			WTP ≥$100 for Rodent-Targeted Pesticide (n = 244)		
	n (%)	uOR (95% CI)	aOR (95% CI)	n (%)	uOR (95% CI)	aOR (95% CI)	n (%)	uOR (95% CI)	aOR (95% CI)
Age									
≥50 y	212 (72)	1.17 (0.86-1.60)		371 (73)	1.20 (0.94-1.53)		174 (71)	1.08 (0.78-1.48)	
18-49 y	84 (28)			136 (27)			70 (29)		
Education									
College/Grad school	273 (93)	2.08[b] (1.27-3.41)		466 (92)	2.00[b] (1.31-2.78)		226 (93)	1.79[c] (1.06-3.03)	
Elementary/Middle/High school	22 (7)			40 (8)			18 (7)		
Income									
≥$100 000	196 (75)	2.71[b] (1.95-3.77)	2.76[b] (1.96-3.89)	318 (71)	2.40[b] (1.88-3.08)	2.70[b] (2.08-3.48)	169 (77)	2.90[b] (2.05-4.12)	3.17[b] (2.18-4.59)
<$100 000	66 (25)			131 (29)			50 (23)		
Sex									
Female	143 (48)	1.61[b] (1.21-2.14)	1.55[c] (1.12-2.14)	273 (54)	1.53[b] (1.22-1.91)	1.52[b] (1.19-1.95)	133 (55)	1.45[c] (1.09-1.94)	1.59[c] (1.15-2.21)
Male	153 (52)			234 (46)			111 (45)		
Self-rated knowledge of LD									
Some/A lot	261 (88)	2.32[b] (1.55-3.48)		433 (86)	1.61[c] (1.20-2.17)		206 (84)	1.36[d] (0.92-2.01)	
None/A little	35 (12)			72 (14)			38 (16)		
Perceived prevalence of LD									
Common/Very common	222 (76)	2.10[b] (1.53-2.88)	1.86[b] (1.30-2.66)	371 (74)	1.88[b] (1.47-2.40)		186 (77)	1.73[b] (1.24-2.43)	
Rare/Somewhat common	72 (24)			128 (26)			56 (23)		
Perceived severity of LD									
Very severe	199 (68)	1.22 (0.90-1.64)		338 (67)	1.35[c] (1.07-1.70)	1.52[b] (1.18-1.97)	163 (67)	1.23[d] (0.90-1.66)	
Not/Moderately severe	95 (32)			165 (33)			79 (33)		
Perceived likelihood of contracting TBD next year									
Very likely	25 (9)	1.31 (0.77-2.22)		49 (10)	1.55[c] (1.03-2.32)		34 (15)	2.13[b] (1.35-3.37)	2.14[b] (1.28-3.59)
Unlikely/Moderately likely	251 (91)			428 (90)			194 (85)		
Ever been diagnosed with TBD									
Yes	84 (28)	1.39[c] (1.01-1.92)		156 (31)	1.14 (0.90-1.45)		78 (32)	1.18 (0.86-1.61)	
No	212 (72)			351 (69)			166 (68)		
State									
Connecticut	111 (38)	1.69[c] (1.25-2.28)	1.51[c] (1.10-2.13)	202 (40)	1.64[b] (1.30-2.07)	1.71[b] (1.33-2.22)	91 (37)	1.26[d] (0.93-1.70)	
Maryland	185 (62)			305 (60)			153 (63)		

Abbreviations: aOR, adjusted odds ratio; LD, Lyme disease; TBD, tick-borne disease; uOR, unadjusted odds ratio; WTP, willingness to pay.

[a] *Adjusted models controlled for all covariates listed in the table. WTP value ranges used for yard treatments: $0, $1-99, $100-299, $300-499, $500-1000, and >$1000. WTP value ranges used for permethrin-treated clothing: $0, $1-24, $25-49, $50-74, $75-100, and >$100.*

[b] $P < .01$.

[c] $P < .05$.

[d] $P < .20$.

TABLE 2

Unadjusted and Adjusted Odds Ratios for 1883 Respondents Willing to Pay $25 or More for 3 Categories of Permethrin-Treated Clothing by Demographics, Knowledge, Attitudes, and History of Tick-Borne Disease, Connecticut and Maryland, 2016-2017[a]

	WTP ≥$25 for Self-treated Clothing (n = 574)			WTP ≥$25 for Professionally Treating One's Own Clothing (n = 382)			WTP ≥$25 for Purchasing Pretreated Clothing (n = 804)		
	n (%)	uOR (95% CI)	aOR (95% CI)	n (%)	uOR (95% CI)	aOR (95% CI)	n (%)	uOR (95% CI)	aOR (95% CI)
Age									
≥50 y	403 (70)	1.38[b] (1.10-1.74)		250 (65)	1.54[b] (1.14-2.08)	1.44[b] (1.06-1.96)	535 (67)	1.35[b] (1.06-1.74)	
18-49 y	171 (30)			132 (35)			269 (33)		
Education									
College/Grad school	513 (89)	1.15 (0.82-1.61)		348 (91)	0.92 (0.54-1.57)		724 (90)	1.32 (0.90-1.92)	
Elementary/Middle/High school	61 (11)			33 (9)			80 (10)		
Income									
≥$100 000	309 (61)	1.47[c] (1.17-1.86)	1.44[c] (1.14-1.81)	216 (64)	1.33[d] (0.97-1.83)		441 (62)	1.67[c] (1.29-2.16)	1.62[c] (1.24-2.12)
<$100 000	201 (39)			123 (36)			270 (38)		
Sex									
Female	251 (44)	0.80[b] (0.64-0.99)		167 (44)	0.62[c] (0.46-0.83)	0.65[b] (0.48-0.88)	385 (48)	0.84 (0.66-1.07)	
Male	323 (56)			214 (56)			417 (52)		
Self-rated knowledge of LD									
Some/A lot	496 (87)	1.86[c] (1.39-2.49)	1.86[c] (1.36-2.52)	313 (82)	1.20 (0.83-1.74)		678 (85)	1.87[c] (1.39-2.52)	1.58[b] (1.12-2.22)
None/A little	77 (13)			69 (18)			123 (15)		
Perceived prevalence of LD									
Common/Very common	385 (68)	1.26[d] (1.01-1.59)		251 (67)	1.01 (0.74-1.39)		539 (69)	1.46[c] (1.13-1.88)	1.35[b] (1.01-1.79)
Rare/Somewhat common	179 (32)			122 (33)			246 (31)		
Perceived severity of LD									
Very severe	371 (65)	1.18[d] (0.95-1.48)		240 (63)	1.08 (0.79-1.46)		512 (64)	1.13 (0.88-1.45)	
Not/Moderately severe	199 (35)			139 (37)			288 (36)		
Perceived likelihood of contracting TBD next year									
Very likely	54 (10)	1.57[b] (1.05-2.35)		28 (8)	0.98 (0.56-1.71)		59 (8)	0.90 (0.58-1.41)	
Unlikely/Moderately likely	480 (90)			318 (92)			683 (92)		
Ever been diagnosed with TBD									
Yes	188 (33)	1.40[b] (1.11-1.77)		112	1.18 (0.85-1.64)		216 (27)	0.87 (0.67-1.14)	
No	386 (67)			270			588 (73)		
State									
Connecticut	197 (34)	1.11 (0.88-1.39)		124	0.94 (0.69-1.29)		269 (33)	1.18 (0.91-1.53)	
Maryland	377 (66)			258			535 (67)		

Abbreviations: aOR, adjusted odds ratio; LD, Lyme disease; TBD, tick-borne disease; uOR, unadjusted odds ratio; WTP, willingness to pay.

[a]Adjusted models controlled for all covariates listed in the table. WTP value ranges used for yard treatments: $0, $1-99, $100-299, $300-499, $500-1000, and >$1000. WTP value ranges used for permethrin-treated clothing: $0, $1-24, $25-49, $50-74, $75-100, and >$100.

[b]P < .05.

[c]P < .01.

[d]P < .20.

pay $100 or more for chemical or natural treatment. Having a higher perceived prevalence of LD was associated with being willing to pay $100 or more for chemical treatment. Most respondents were willing to pay for PTC but not more than $24. They were most willing to pay for self-treatment, followed by purchasing pretreated clothing, and, finally, sending their own clothes for professional treatment.

While most reported WTP less than $100 for yard treatment, most companies recommend multiple treatments per season, at $75 to $100 per treatment (TruGreen, Orkin, Terminix, oral communication, September 2019). Given the endemic nature of TBD in the study areas, a community approach to tick control may be feasible, with cost sharing among several households. Companies might offer treatment options that can better accommodate homeowners' WTP, such as reduced costs, if multiple properties agree to treatment.

Seventy-four percent of respondents reported they had never heard of PTC, and 84% reported never wearing it. After learning what PTC is, most were willing to pay some amount for it, suggesting this is an acceptable, potentially untapped method of prevention that merits further research. However, based on respondents' WTP for PTC and considering pricing of pretreated clothing, respondents would only be able to purchase one T-shirt or a pair of socks at $24 (Insectshield.com, November 2019). Increasing the awareness that PTC can also protect against mosquitoes could increase WTP. Respondents reported they would prefer to self-treat clothing, which is possible to do for less than $25 (a 24-oz bottle of permethrin treats 4 outfits, approximately $15) (Amazon.com, November 2019). However, the duration of effectiveness of PTC varies, with professionally treated clothing lasting approximately 70 washings (Insectshield.com, October 2020) and self-treatment lasting approximately 6 washings (Amazon.com, October 2020).

Gould et al[14] also found that most participants were unwilling to pay more than $100 for tick control. However, overall, 19% of those respondents would not spend any money on tick control whereas 14% and 15% of our respondents would not spend any money on yard treatments and PTC, respectively. This difference could be due to increasing TBD incidence over the last decade. In 2017 inflation-adjusted numbers, the median income range was $83 445 to $115 576 for Maryland counties surveyed and $63 914 to $151 399 for Connecticut towns surveyed (date.census.gov, October 2020). Approximately half of respondents reported an income of $100 000 or more in Maryland (54%) and Connecticut (51%), meaning that our respondents' household incomes were roughly similar to the general population of these areas.

These findings are subject to limitations. While a low response rate is typical for surveys among the general population, it introduces the potential for selection bias. It is possible those with a higher TBD concern and a greater likelihood of WTP for prevention were more likely to respond, possibly biasing our results away from the null. These results are from a convenience sample of residents in select high LD incidence areas in Connecticut and Maryland and may not be generalizable to other geographic areas.

Implications for Policy & Practice

- Our results suggest that yard treatments, particularly with natural pesticides, are acceptable forms of TBD prevention for residents of Connecticut and Maryland.
- Self-treated PTC seems to be an acceptable and affordable prevention method, though awareness of this method is low. The amount people are willing to pay for these forms of prevention is less than current market pricing. Finding ways to increase awareness of PTC should be pursued.
- Efforts are needed to make existing prevention options more affordable and to identify alternative, less expensive methods of TBD prevention. For example, more people may be interested in treating their properties for ticks if there was an option to treat the community and share the cost with their neighbors.

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