Appendix: Evaluating public acceptability of a potential Lyme disease vaccine in the United States

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Table A1. Select vaccine acceptability survey questions and response options*

Question	Response options
If a Lyme disease vaccine were available, would you get vaccinated?	Yes No Don't know/not sure
How concerned are you about the safety of a Lyme disease vaccine?	Not at all concerned Somewhat concerned Very concerned Don't know/not sure
How much would the cost of a Lyme disease vaccine affect your decision to get vaccinated?	Not at all Some A lot Don't know/not sure
How much would a positive recommendation from your doctor affect your decision to get vaccinated?	Not at all Some A lot Don't know/not sure
Has anyone in your household ever been diagnosed with LD by a health care professional?	Yes No Not sure
How concerned are you about getting LD in the future?	Not at all concerned Somewhat concerned Very concerned Don't know/not sure
In the months April-October, do you spend time in or near places where ticks could get on you (for example, wooded or brushy areas, whether in your yard, other yards, or recreational areas)?	Yes, daily Yes, weekly Yes, monthly Yes, less than once a month No Don't know/not sure
Which of the following measures do you take to prevent ticks from getting on you? (Check all that apply)	Apply insect repellent Check for ticks Use special clothing Use sprays in your yard Other measures None of these
How confident are you that these measures can prevent LD?	Very confident Somewhat confident Not at all confident Don't know/not sure
Where do you most often get information about Lyme disease? (choose one)	Doctor, nurse, or other medical professional Naturopath or chiropractor Friends or family members Google or other internet search engines Health websites Social media sites Other

How confident are you that recommended vaccines benefit people?	Very confident Somewhat confident Not at all confident Don't know/not sure
Where do you usually get vaccines? (choose one)	Doctor's office, clinic, or hospital Pharmacy or drug store Health department Workplace School clinic Other Don't know I do not get vaccines
**** Questions for the parent survey were identical, but phrased with the child as vaccinee (e.g., "If a LD vaccine were available, would you vaccinate your child?")***	

Table A2. Confounders identified *a priori* and adjusted for in multinomial logistic regression models

	Confounders											
Model	**Vaccinee age category**	**Gender**	**State**	**Race**	**Education**	**Metro status**	**Healthcare provider recommen-dation**	**Past LD diagnosis in household**	**Concern about future LD diagnosis**	**Time spent in tick habitat**	**Current use of LD prevention measures**	**General confidence in vaccines**
Vaccinee age category*												
Gender*												
State	X				X							
Race						X						
Education	X	X	X	X		X						
LD vaccine safety concerns	X	X			X		X	X	X	X	X	X
HCP influence on LD vaccination	X	X			X			X	X	X	X	X
LD vaccine cost concerns	X	X			X			X	X	X		X

*Unadjusted models

Table A3. Observed and weighted respondent characteristics, N = 3206

Characteristic	N	Unweighted %	Weighted % (95% CI) *
Demographics			
Gender**			
Female	1878	59	54
Male	1328	41	46
Age category (years)**			
< 18	246	8	15
18-44	772	24	33
45-64	1225	38	34
65+	963	30	17
State			
Connecticut	679	21	20
Maryland	808	25	27
Minnesota	998	31	20
New York	721	23	33
Race			
White	2852	90	85 (84, 86)
Non-white	322	10	15 (14, 16)
Education			
Some college or less	1248	39	35 (33, 36)
Bachelor's degree or higher	1941	61	65 (64, 67)
Metropolitan status			
Large central metropolitan area	674	21	28
Other	2532	79	72
LD history, attitudes, and practices			
Past LD diagnosis in household			
Yes	640	20	18 (17, 19)
No	2563	80	82 (81, 83)
Concern about future LD diagnosis			
Yes	2813	88	86 (85, 86)
No	391	12	14 (14, 15)
Spend time in tick habitat			
At least weekly	2376	74	71 (70, 73)
Monthly or less	828	26	29 (27, 30)
Currently use LD prevention measures			
Yes	2948	92	92 (91, 93)
No	258	8	8 (7, 9)
Confidence in LD prevention measures			
Yes	2041	70	70 (68, 71)
No	896	30	30 (29, 32)

Confidence in general vaccines			
Yes	3022	94	94 (93, 95)
No	182	6	6 (5, 7)
LD vaccine attitudes			
Willing to receive LD vaccine			
Yes	2098	65	64 (62, 65)
No	190	6	7 (6, 8)
Don't know	918	29	30 (28, 31)
LD vaccine safety concerns			
Yes	2257	70	71 (70, 72)
No	948	30	29 (28, 30)
HCP influence on LD vaccination			
Yes	2858	89	89 (88, 89)
No	348	11	11 (11, 12)
LD vaccine cost concerns			
Yes	2036	64	63 (62, 65)
No	1168	36	37 (35, 38)

[*] County distributions of gender and age were used for post-stratification; as such, these point estimates are fixed at the population values and have no associated interval estimate. Because state and metropolitan status are based on county population totals, these point estimates are also fixed.

[**] Gender and age categories represent the potential vaccinee, i.e., adult respondents and the children for whom parents responded.

Appendix: Evaluating public acceptability of a potential Lyme disease vaccine in the United States

Section 1. Heckman-type selection models

We evaluated non-random missingness in our outcome variable, willingness to receive a LD vaccine, in relation to non-response (i.e., selection bias) using Heckman-type selection models, also called generalized Tobit models [39-41]. Heckman-type selection models correct for selection bias when nonparticipation is determined both by observed and by unobserved factors. Performance depends on the availability of selection variables that determine survey participation but do not independently affect the outcome of interest. Heckman models use two steps to first model the selection process using one or more independent selection variables and then model the outcome equation (i.e., the regression equation for the outcome of interest). The key feature of Heckman-type selection models is that a correlation between the unobserved error terms in the selection equation and outcome equation is estimated (r). The coefficient of the inverse Mill's ratio represents the covariance between the error terms, and has an associated p-value. These results of the two-step process indicate whether selection bias is present and, if so, a correction factor incorporating the coefficient of the inverse Mill's ratio is applied to results.

We chose two selection variables, presence of children in the household and household member count, under the assumption that these variables were predictive of participation in the survey, but unrelated to the outcome, willingness to receive a LD vaccine. For example, those with children in the household and/or higher numbers of household members may not have time to participate in a voluntary survey. All variables in the selection equation must be available for all sampled individuals, regardless of participation. Independent variables for all sampled households were purchased from the marketing firm from which addresses were purchased. The selection equation included the following:

Selection ~ endemicity + property type + household income + presence of children in household + household member count

The outcome equation includes the independent variables from the selection equation, excluding the selection variables. The outcome equation included the following:

Vax decision ~ endemicity + property type + household income

Table A4 shows the results of the Heckman-type selection models using the two-step process. Of note, r = 0.7 and the coefficient of the inverse Mill's ratio is 0.4305 (p = 0.5307), meaning that the data are consistent with no selection bias (i.e., the null hypothesis that the errors are uncorrelated cannot be rejected).

These results are limited by the fact that only variables available for the entire sample could be used in the evaluation. Further, the accuracy of these variables typically used for marketing research are questionable, plus some records were missing observations for these variables. Lastly, our assumption that the selection variables, presence of children in household and household member count, are unrelated to the willingness to be vaccinated outcome is somewhat tenuous. For example, because children are one of the groups at highest risk for LD, parents with children in the household may be more likely to participate in a survey about a LD vaccine and also express willingness to vaccinate their children.

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Table A4. Results of Heckman-type selection models

	Dependent variable: Willingness to receive LD vaccine (0= No/DK; 1 = Yes)
Terms	Coefficient (95% CI)
Endemicity:	-0.0223
Non-endemic	(-0.1285, 0.0840)
Property type:	0.0690
Single family dwelling unit	(-0.0825, 0.2206)
Household income:	0.0709
> $70K	(-0.0868, 0.2286)
Constant	-0.2494
	(-2.4066, 1.9078)
Observations	34,667
R^2	0.0006
Adjusted R^2	-0.0009
Log Likelihood	
Akaike Inf. Crit.	
rho	0.6958
Inverse Mills Ratio	0.4305 (0.5307)

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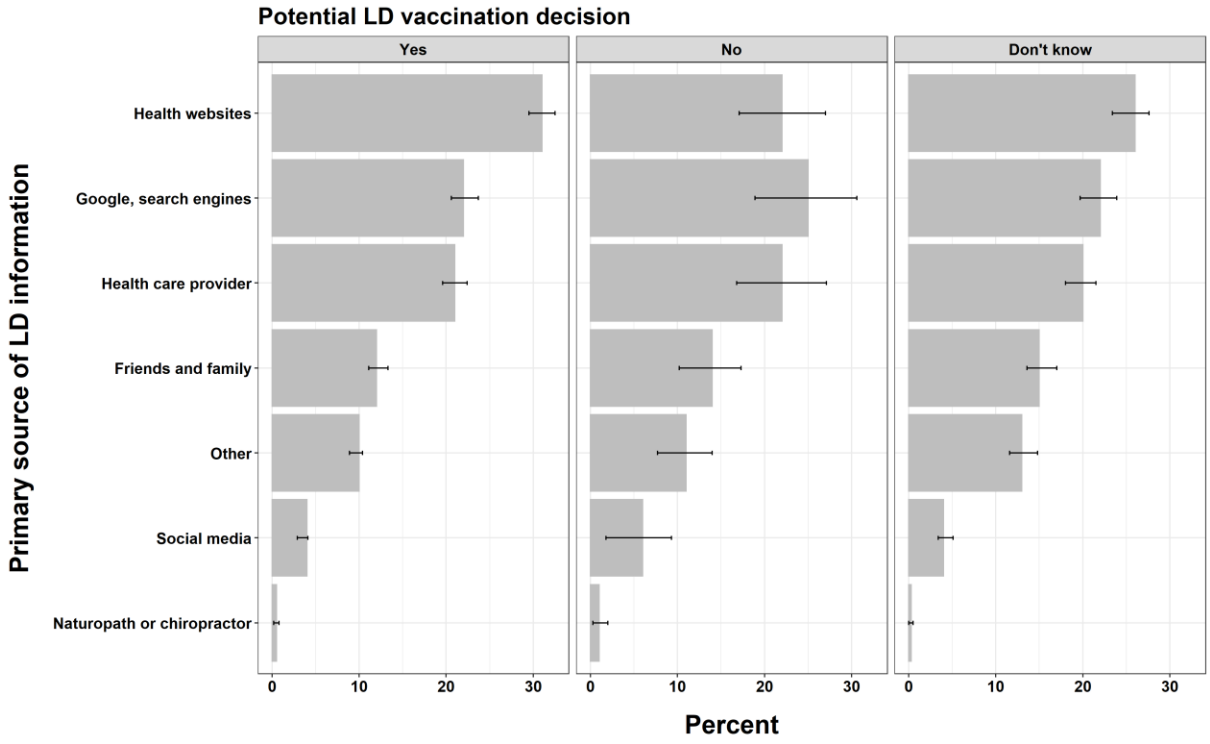
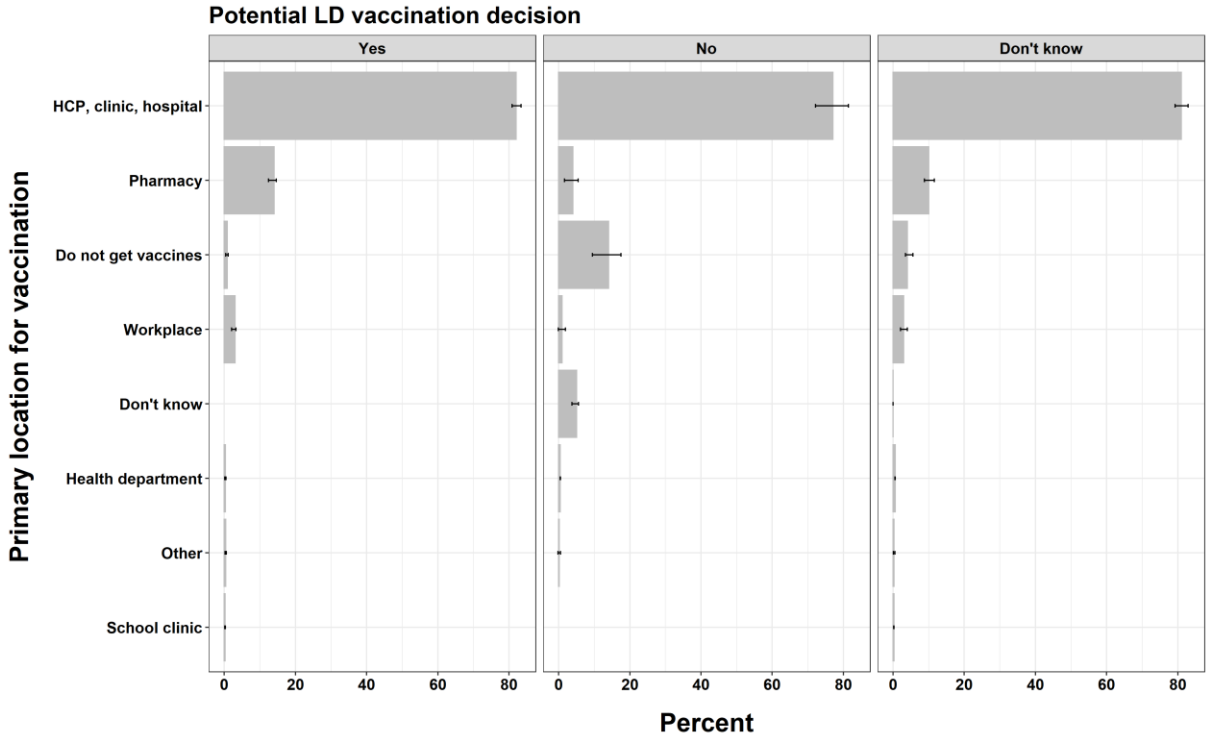
55 *[1]The selection equation for the Heckman selection model used presence of children and household member count*
56 *as selection variables, i.e., instrumental variables*
57 *Note:* *p**p***p<0.01

Figure A1. Respondents' primary source for LD information, by potential LD vaccination decision, weighted % and 95% confidence interval*



*95% confidence interval shown in the black bars

Figure A2. Respondents' primary location for receiving vaccination, by potential LD vaccination decision, weighted % and 95% confidence interval*



*95% confidence interval shown in the black bars