TOURIST BEHAVIOUR AND TICK-BORNE DISEASE RISK

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ABSTRACT

Lyme disease is the leading tick-borne disease in the US, with incidences increasing over the past decades due in part to climate change. Visitors to natural areas involved in nature-based activities are at heightened risk of Lyme disease exposure. We surveyed 430 visitors in Acadia National Park to understand the personal protective behaviours and associated barriers to adoption, perceived tick-borne disease risk, and travel behaviour. A two-step cluster analysis revealed two visitor segments: adventurists and sightseers. Adventurists were less likely to perform protective behaviours against tick-borne disease, but performing a tick check was the most commonly reported preventative behaviour for both groups (62%). The most commonly cited barriers to performing a tick check were lower perceived risk of tick bites and Lyme disease for both groups. Both groups also reported that the number one barrier to wearing protective clothing was the hot summer weather. This research has implications for tourism managers to design effective communication materials to reduce the risk of tick-borne disease for different visitor segments.

Keywords: Nature-based tourism, Cluster analysis, Lyme disease, Acadia National Park, Ticks, Health risk, Survey research, Maine

1 INTRODUCTION

Lyme disease (LD), transmitted through the bite of an infected blacklegged tick, is the most commonly diagnosed tick-borne disease (TBD) in the United States, with over 42,000 reported cases in 2017 [1]. Lyme disease poses a significant threat to those travelling to rural areas partaking in outdoor activities [2]. Risks may be heightened for tourists unaware of LD who lack the necessary knowledge and resources to properly protect themselves [3]. On the other hand, impacts from localized climate change, such as increases in LD risk, can impact the quality of the visitor experience [4] and their decisions regarding future travel plans [5]. For that reason, exposure to LD has major implications for both visitors and tourism managers. The purpose of this study is to analyse the role of activity type and associated factors that may influence personal protective behaviours against TBD in Acadia National Park, Maine, United States of America.

Tick-borne disease risk management primarily focuses on protective measures to reduce TBD risk. Personal protective measures include using insect repellents containing DEET, avoiding contact with ticks, performing tick checks after recreating outdoors, and showering within 2 hours of coming indoors [6]. Despite the wide range of protective measures against TBD and high knowledge of LD symptoms, uptake has been poor [7]-[8]. Large differences exist in the type of protective measure used among the public, with performing a tick check as the most commonly reported behaviour [9]-[10] and using insect repellent as the least commonly reported [11]. Similarly, there have been disparities in the effectiveness of education to increase protective behaviours [3], [12]. Hence, understanding the determinants of protective measure adoption is important to addressing this health risk.

Potential factors that may influence the uptake of protective behaviours against TBD have been extensively studied. Perceived efficacy of a given protective measure has been shown to be strongly associated with performing that measure [10]. Knowledge and concern are also significant predictors of protective behaviour [13]-[14]. There do, however, exist differences in the potential drivers for the use of different protective measures. Knowledge about LD [15] and exposure to ticks [16] have been significantly associated with tick checks but not with other measures such as tick repellent [15].

In tourism studies the use of segmentation analysis can help compare groups of visitors with different characteristics to identify variations that exist between these groups [17] in terms of travel or health behaviours. Acadia National Park brings visitors from all over the globe who engage in a variety of recreational activities; therefore, determining if differences exist in how diverse visitor groups perceive and respond to the risk of TBD can help guide risk communication strategies that seek to increase adoption of personal protective behaviours. The goal of this study is to (a) investigate the differences in socio-demographics, perceived risk, and personal protective behaviours by visitor group; and (b) identify barriers to adopting protective behaviours by visitor group.

2 METHODS

2.1 Study area

Acadia National Park (ANP) is located in Maine, which is in the north-eastern part of the United States. Over the past several decades there have been increases in incidences of LD due in part to climate change [18]. In 2017, Maine had 1,852 Lyme diagnoses, making it the state with the highest amount of confirmed Lyme cases per 100,000 residents [19]. Tourism is one of the largest industries in the state of Maine. In particular, ANP offers a diverse range of recreation activities that attract over 3 million visitors every year, including a scenic road that loops through the entire park, guided programs and museums, more than 150 miles of trails for all skill-levels, campgrounds, and opportunities for rock climbing, kayaking, bird watching [20]. ANP was selected as our study site for the following reasons: (1) the park is the 8th most visited National Park in the United States, with outdoor recreation as primary attraction, hence putting millions of tourists per year at risk of exposure TBD; (2) TBD is expected to increase as a result of climate change and increases visitation in the study area; (3) visitation coincides with peak periods of black-legged tick activity; and (4) a 2016 study found that ANP visitors identified heightened risk of exposure to vector-borne disease as an important concern regarding future visitation [5] that may have economic implications for nearby gateway communities.

2.2 Survey design and sampling procedure

The study used a mixed-mode survey, with an on-site 5-minute intercept component followed by a longer online self-administered survey. The intercept survey included socio-demographic and travel behaviour questions as well as questions regarding perceived TBD risk, and was aimed at increasing the likelihood that visitors would complete the longer self-administered survey. The self-administered instrument consisted of questions on travel behaviour, and protective behaviours to reduce TBD risk. Data were collected between May – October 2018 in ANP.

Participants were selected using a two-stage cluster probability sample [21]. The sampling dates were first randomly selected and the visitor groups were then selected on-site using a systematic probability sampling technique [22]. Survey administrators approached random walking groups by using a pre-selected interval (i.e. every 3rd group), and interviewed the person with the most recent birthday, if willing. Following the short on-site survey, participants were handed a postcard with a link to a self-administered online survey to complete once they returned home. Dillman's Tailored Design Method was used to maximize response rate by asking visitors for an email or mailing address in order to send up to two reminders regarding the online survey [23]. Of the 1,252 on-site surveys collected, 430 respondents completed the self-administered survey (34% response rate).

2.3 Measures

2.3.1 Activities. Respondents were asked to select which activities they participated in during their visit to ANP out of a list of 33 options. Respondents were then asked to select their primary activity from that same list of options. Participants were also asked if they would make changes in their future travel plans based on TBD concerns (change destination, engage in different recreational activities, change the timing of their travel).

2.3.2 Perceived risk. Respondents were asked to rate their responses to the question of whether or not the risks that ticks pose to humans are (1) *avoidable* and (2) *controllable* using 7 -point Likert scale where 1 = strongly agree and 7 = strongly disagree. The two questions were combined using a mean score, where answers to both questions were required, so that higher scores indicate higher perceived risk. These two questions were highly correlated with a Pearson's correlation of 0.60.

2.3.3 Protective behaviour**.** Participants were asked to select whether or not they engaged in 8 personal protective behaviours *never, sometimes,* or *always.* Protective behaviours included *staying on trails, performing tick checks, tucking pants into socks, avoiding activities that expose one to ticks, avoiding recreating outdoors, using insect repellent, wearing light-coloured clothing,* and *wearing protective clothing.* Responses were coded so that 0 = *never*, 1 = *sometimes*, and 2 = *always.* A sum score was calculated so that higher scores reflect higher overall protective behaviour ($\alpha = 0.76$). Scores are out of 16.

2.3.4 Barriers to protective behaviours. If a participant did not select always for the following protective behaviours: performing tick checks or wearing protective clothing, they were asked to select their top three barriers to that behaviour out of a list of 5 options. Both behaviours listed: there is a low chance of getting Lyme disease, there is a low chance of getting bit by a tick, and that behaviour is overdone as potential barriers. Other barriers for performing tick checks included not knowing how to remove a tick and not knowing how to recognize a tick. Responses were coded so that 1 indicates a top barrier and 0 indicates that that is not a top barrier.

2.3.5 Socio-demographics. Lastly, a range of socio-demographics was collected including age, gender (0 = female; 1 = male), education collapsed into two categories where 0 = higher education (college degree); 1 = lower education (no college degree), their home state/country (1 = states with LD; 2 = all other), and whether or not they are a 1st time visitor to ANP (0 = 1st time visitor; 1 = repeat visitor).

2.4 Data analysis

There were a total of 430 responses to the self-administered survey. Non-response bias was measured using Pearson's chi-square test of independence (χ^2) to compare those who responded to the on-site survey (n = 1252) with those who completed the self-administered survey (n = 429). There was no statistical differences in first time visitation (χ^2 = 1.45, 1 df, p = 0.23), knowledge of what a tick is (χ^2 = 2.85, 1 df, p = 0.09), and gender (χ^2 = 2.44, 1 df, p = 0.12); however, there was a statistical difference in experience with TBD (χ^2 = 5.31, 1 df, p = 0.02) with those taking the on-site survey having relatively fewer experience with TBD compared to those taking the self-administered survey. It is possible that those who have personally experienced TBD were more interested in the study and therefore were more inclined to take the self-administered survey, which would account for this difference.

A multivariate two-step cluster analysis was run to segment ANP visitors. Cluster analysis can be useful in the context of tourism and parks management as means to understand visitor group needs [24]. Clustering was based off of the number of nature-based activities (either somewhat nature-based or nature-based) and whether the primary activity was nature based (Table 1) as modified by the procedure used in Wilkins [25].

Table 1: Categorization of types of activities listed used for two-step cluster analysis.

Categories	Activities
Not nature-based (0)	Arts or cultural activity, Concert or festival, Dining at Jordan Pond House
Sightseers (1)	Sightseeing or driving for pleasure
Somewhat nature-based (2)	Bird Watching, Going to the beach, Picking berries, Picnicking, Taking horse or carriage ride, Trail running, Walking my dog, Wildlife viewing
Nature-based (3)	Backpacking, Biking, Camping, Hiking, Kayaking, Non-technical mountain climbing, Walking on carriage roads, Swimming

Independent samples t-tests were used to test for differences for the continuous variables of perceived risk, and protective behaviour. Levene's statistic was used to test the assumption of equal variances of groups. If homogeneity of variance was violated an adjustment was made using the Welch-Satterthwaite method [26]. Cohen's d was used to assess effect size for independent samples and Welch's t-test results. Chi-square tests were run to examine the differences in activity groups for each protective behaviour. Cramer's V was used for effect size and adjusted standardized residuals (ASR) were used as a post-hoc test, with those two standard deviations or more away from the expected mean reported. Barriers to protective behaviours against TBD were investigated using descriptive statistics. The proportion of respondents who selected each barrier was calculated for each group using the number of respondents who did not *always* perform that protective behaviour. All data analyses were done in SPSS 25.0.

3 RESULTS

3.1 Demographic profile, trip characteristics, and potential travel behaviour change

As shown in Table 2, the majority of respondents were non-residents of Maine (93%) with 54% from areas with LD and 39% from areas without LD. Most respondents (61%) were first time visitors, travelling with family (78%). The 60-69 year age group had the most respondents (28%) followed by the 50-59 age group (22%) and then the 40-49 age group (20%). Finally, there was a majority female sample (60%). In addition, almost half of the respondents selected hiking on trails (49%) as their primary activity with sightseeing as the 2nd most selected response (27%), and biking as the 3rd (7%). Over a quarter of respondents

Table 2: Socio-demographics, trip characteristics and potential travel behaviour change.

Variable	Subcategory	Number of responses	Percent
Residency	Maine Areas with Lyme Disease All other areas	25 187 137	7% 54% 39%
First time visitation to ANP	First time visitors Repeat visitors	253 164	61% 39%
Type of personal group	Alone Family Friends Family and Friends	15 296 44 25	4% 78% 12% 7%
Age (years)	< 30 30 – 39 40 – 49 50 – 59 60 – 69 > 69	27 55 72 80 101 32	7% 15% 20% 22% 28% 8%
Gender	Male Female	154 229	40% 60%
Travel behaviour change from TBD concern	Change destination Change in outdoor activities Change time of year to travel	135 98 66	35% 26% 17%

participated in the following activities at ANP: hiking on trails (76%), sightseeing/driving for pleasure (75%), going to the beach (40%), viewing wildlife (39%), shopping in the park (36%), and dining at Jordan Pond House (28%). Further, when asked about changes in travel behaviour resulting from concerns with TBD, 35% of participants expressed that they would change their travel destination, 26% would change their outdoor recreation activities, while 17% would consider traveling during another time of year.

3.2 Recreation activity groups and their differences

The clustering analysis resulted in two visitor segments: adventurists and sightseers (Table 3). Adventurists were those who participated in more nature-based activities (M = 4.5) and whose primary activity was nature-based, measured on a scale from 0-3 (M = 3.0). Sightseers were those who participated in fewer nature-based activities (M = 2.5) and whose primary activity was less-nature based (M = 1.2). Table 4 shows there is no significant difference in gender (χ^2 (1, N = 374) = 1.21, p = 0.27) or first time visitation (χ^2 (1, N = 303) = 2.52, p = 0.11). Education and region were significantly different between activity groups, with adventurists tending to be more highly educated (χ^2 (1, N = 374) = 1.21, p = 0.27) and from areas with the presence of LD (χ^2 (1, N = 350) = 8.58, p = 0.00).

As shown in Table 5, t-tests elicited no significant differences between activity groups in perceived risk (t(1) = 0.15, p = 0.88). Overall, sightseers (M = 7.97) reported performing protective behaviours against TBD more often than adventurists (M = 7.27) on a scale from 0 to 16 (t(1) = -2.02, p = 0.03); the overall protective behaviour comprises 8 measures.

Table 3: Descriptions and characteristics of the two activity visitor groups (clusters).

Visitor group	Adventurists	Sightseers
Description	Tourists who tended to participate in more nature-based activities and whose primary activity was nature-based, like hiking, camping, etc.	Tourists who tended to participate in fewer nature-based activities and whose primary activity was less nature-based, such as sightseeing
Size	260 (65%)	143 (35%)
Inputs	Mean number of nature-based activities: 4.49 Primary activity nature-based: 3.0	Mean number of nature-based activities: 2.53 Primary activity nature-based: 1.15

Table 4: Comparisons of socio-demographics and trip characteristics broken down by activity group (reported as percentages).

Variable	Adventurists (%)	Sightseers (%)	Chi-square (sig)	Cramer's V (Φ_C)
Gender	$N = 236$	$N = 138$	1.21 (0.27)	0.06
Male	38	43		
Female	62	57		
Home state/country	$N = 219$	$N = 131$	8.58 (0.00)	0.16
Areas with LD	66	50		
All other areas	44	50		
Education	$N = 238$	$N = 138$	10.91 (0.00)	0.17
Lower Education	8	20		
Higher Education	92	80		
Visitation	$N = 260$	$N = 143$	2.52 (0.11)	0.08
First time visitor	57	65		
Repeat visitor	43	35		

Table 5: Comparisons of perceived risk, and protective behaviour broken down by activity group (reported as mean values).

Variable	Adventurists (N)	Sightseers (N)	Levene Stat (sig)	t-test (sig)	Cohen's D
Perceived Risk	2.65 (241)	2.63 (138)	1.58 (0.21)	0.15 (0.88)	0.01
Protective Behaviour	7.27 (244)	7.97 (137)	7.79 (0.01)	-2.02 (0.03)	0.24

When examining individual protective behaviours, there is no significant difference in performing a tick check (χ^2 (2, N = 379) = 5.36, p = 0.07) or using insect repellent (χ^2 (2, N = 370) = 1.38, p = 0.50) between adventurists and sightseers as shown in Table 6. There are, however, a relatively larger percentage of sightseers (8%) who *never* perform a tick check compared to adventurists (3%). Despite this, performing a tick check is the most commonly performed protective behaviour for both groups (62% always perform a tick check). The significant difference in overall protective behaviour can be attributed to

Table 6: Comparisons of types of protective behaviours against TBD broken down by activity group (reported as percentages).

Variable	Overall (%)	Adventurists (%)	Sightseers (%)	Chi-square (sig)	Cramer's V (Φ_C)
Performing a tick check	*N* = 387	*N* = 244	*N* = 135	5.36 (0.07)	0.20
Never	5	3*	8*		
Sometimes	33	34	32		
Always	62	63	60		
Wearing protective clothing	*N* = 384	N = 242	N = 134	14.59 (0.00)	0.20
Never	9	10	8		
Sometimes	66	72*	56*		
Always	25	18*	36*		
Using insect repellent	*N* = 388	*N* = 244	*N* = 136	1.38 (0.50)	0.06
Never	9	9	7		
Sometimes	54	56	52		
Always	37	35	40		
Avoiding activities that will expose to ticks	*N* = 388	*N* = 244	*N* = 135	9.84 (0.01)	0.16
Never	41	41	42		
Sometimes	54	57	50		
Always	5	2*	8*		
Avoiding recreating outdoors	*N* = 385	*N* = 243	*N* = 133	6.37 (0.04)	0.13
Never	41	83*	74*		
Sometimes	54	16	23		
Always	5	1	3		
Staying on paved trails/gravel	*N* = 386	*N* = 244	*N* = 134	6.07 (0.05)	0.13
Never	14	15	12		
Sometimes	67	70	63		
Always	19	15*	25*		
Tucking pants into socks	*N* = 386	*N* = 244	*N* = 15	11.15 (0.01)	0.17
Never	41	46*	35*		
Sometimes	44	44	43		
Always	15	10*	22*		
Wearing light coloured clothing	N = 385	N = 242	N = 135	6.19 (0.05)	0.13
Never	19	19	20		
Sometimes	66	70*	60*		
Always	15	11*	20*		

Note. Degrees of freedom = 2 for all chi-square tests.
* Indicates adjusted standardized residual (ASR) > 1.96.

sightseers more commonly performing other protective behaviours, such as wearing protective clothing (χ^2 (2, N = 376) = 14.59, p = 0.00).

3.3 How do the barriers to protective behaviours differ between activity groups?

Eighty-two percent of adventurists, compared with only 64% of sightseers do not *always* wear protective clothing. The top overwhelming barrier for both activity groups is that it is too warm in the summer, with 93% of all respondents selecting it as one of their top 3 barriers (Figure 1). Both adventurists and sightseers prioritized similarly other barriers to using protective clothing as a protective measure.

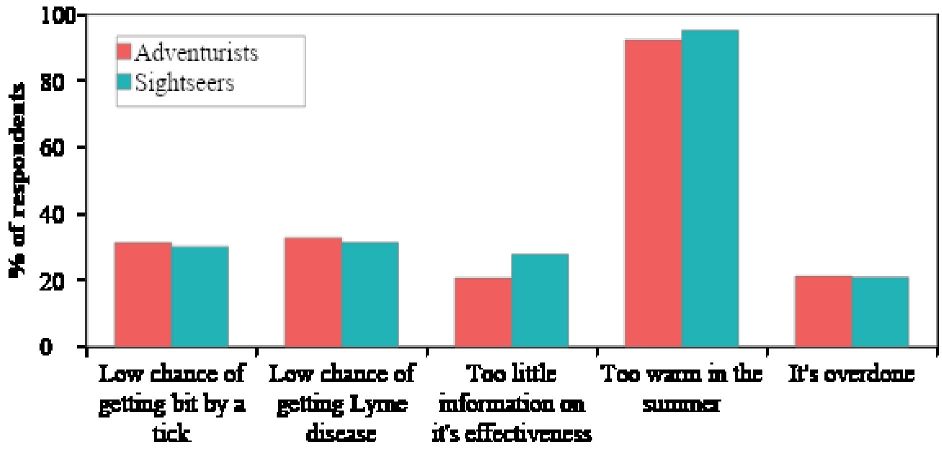

Figure 1: Bar chart of proportion of respondents who selected each barrier to wearing protective clothing for adventurists (pink) and sightseers (blue)

Approximately 40% of both activity groups do not *always* perform tick checks (Figure 2). Adventurists selected *there's a low chance of getting Lyme* as their number one barrier to performing tick checks and *there's a low chance of getting bit by a tick* as their second barrier with 42% and 41% respectively. Sightseers were similar in that they selected both as their top barriers; however, 48% selected *there's a low chance of getting bit by a tick* and only 32% selected *there's a low chance of getting Lyme* as their top barriers to performing tick checks. *It's overdone* was the next highest barrier for adventurists with 19% of respondents selecting it, while *I don't know how to remove a tick* was the next highest barrier for sightseers with 26% choosing it as a top 3 barrier. *I don't know how to recognize a tick* came in last at 11% for all respondents.

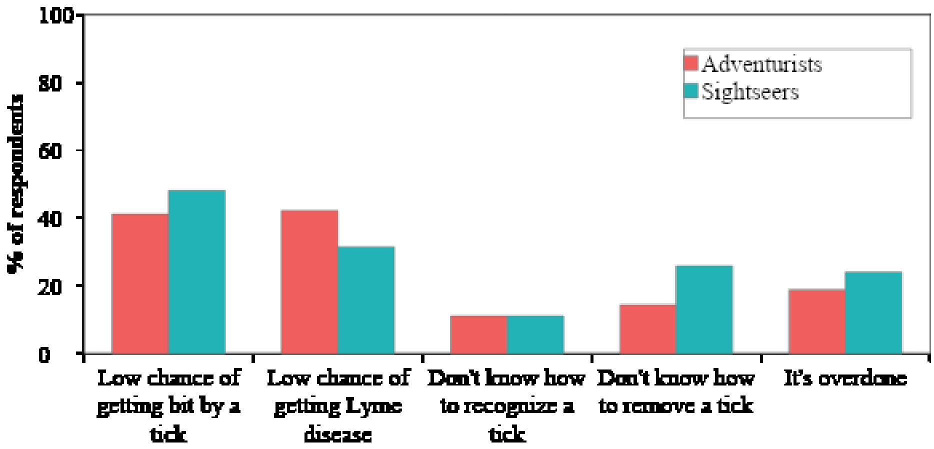

Figure 2: Bar chart of proportion of respondents who selected each barrier to performing a tick check for adventurists (pink) and sightseers (blue).

4 DISCUSSION AND CONCLUSION

Two-step cluster analysis was an effective way to group visitors to ANP based on activity type, with those engaging in more nature-based activities such as hiking and camping (adventurists) falling into one group, while those that primarily sightsee and drive the Park Loop Road (sightseers) fall into another group. Adventurists were more likely to be highly educated and from areas with LD, while sightseers were slightly less educated and from more areas without LD. Despite the differences in socio-demographics, there were no significant differences in perceived risk of ticks between activity groups. Overall, ANP visitors surveyed tend to have low perceptions of risk, with close to 10% of respondents perceiving that risks that ticks pose are avoidable and controllable; findings are in contrast to results from a prior study in Sweden [11] that found that 43% of respondents perceive tick bites as a serious health risk.

Further, differences were found in terms of preventive behaviours, with adventurists having lower overall protective behaviour than sightseers. This is due in part to the types of behaviours measured to reduce TBD risk, such as avoiding recreating outdoors and staying on gravel/trails. It is no surprise that those that engage in more nature-based activities while visiting ANP tend to do some of those behaviours less than those who sightsee regardless of whether or not the behaviour is truly done to avoid ticks. This may also be due in part to a psychological drive to take risks to experience a rush or thrill [27], or their belief that specific TBD protective behaviours might hinder their enjoyment of their preferred recreational activities [28]. Those that engage in nature-based activities at ANP may be less-inclined to wear protective clothing or stay on trails because that would be in opposition to their desire to freely explore the natural setting. It is, however, important to note that both adventurists and sightseers are regularly performing tick checks (62%), which is consistent with previous studies [8], [13]. Further, adventurists are wearing protective clothing less and more often not staying on trails—two protective measures specifically aimed at reducing TBD risk. From a management perspective, this is an important finding given that adventurists are inherently at higher risk of TBD due to the nature of their activities.

The top barrier to wearing protective clothing for both activity groups was that it is too warm in the summer; this finding is similar to those from previous studies [13], [30]. Other top barriers for wearing protective clothing and performing a tick check were a perceived low risk of getting bit by a tick and contracting Lyme disease; these compares findings from previous studies [13]. While it may be difficult to target warm weather as a barrier, increasing visitor's perceptions about the true risks of getting bit by a tick and contracting LD may increase preventative behaviours. More sightseers expressed their inability to remove a tick as a barrier to performing a tick check. While adventurists were relatively more knowledgeable about this, understanding the proper way to remove a tick may be an important way to increase tick checks in sightseers.

Although knowledge can inform risk perceptions and behaviours, research is needed to better understand the factors that determine perceptions of risk, and the drivers and barriers to visitor adoption of TBD protective behaviours while visiting natural settings, like national parks. Factors such as self-efficacy [8], [10], [29]; disgust about ticks [29]; perceived likelihood of being bitten by a tick [14], [29]; likelihood and severity of contracting a TBD [8], [13]; and barriers to adoption [13], may be important in predicting protective behaviours.

The results of this study demonstrate the existence of two main visitor groups to ANP: adventurists and sightseers. Sightseers perform more protective behaviours compared to adventurists. The differences in overall protective behaviour may be due to a variety of factors including the behaviours measured in the survey instrument or adventurists inherent inclination to take more risks; however, performing a tick check is relatively high for both groups. Targeting other protective behaviours such as using insect repellent or wearing protective clothing may require communication strategies that include information about how to properly remove ticks (aimed at sightseers) to increase self-efficacy [29], and the actual risk of contracting a TBD (aimed at adventurists). Risk communication strategies targeted to specific group characteristics will be important to increase risk perception and adoption of protective behaviours [31]. Further research can examine the drivers of protective behaviours in both groups and explore the role of barriers and self-efficacy in preventing certain types of protective behaviours.

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