Letter to the Editor

Lyme Borreliosis-associated Risk Factors in Residents of Beijing Suburbs: a Preliminary Case-control Study*

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A population-based case-control study was conducted to evaluate the relative factors in the environments, agricultural works, outdoor activities, and the effectiveness of Lyme borreliosis (LB)-associated personal protective measures in Beijing. Thirty-four cases and 272 controls were personally interviewed by well-trained interviewers. Venous blood samples were taken from each subject. Sowing or harvesting in summer (OR=2.571, 95% CI: 1.109-5.962), living in house with weeding in the yard (OR=2.247, 95% CI: 1.062-4.755), and residence at the plain area (OR=2.630, 95% CI: 1.050-6.588) were the independent relative factors for seropositive LB. Wearing long pants and clothes with cuffs was the only protective behavior against tick bite (OR=0.186, 95% CI: 0.041-0.846). The findings showed that local farmers were easily infected with LB and almost no protective measure was taken against LB infection. Infection with LB was easier in residents of plain regions. Pets raising and outdoor activities were not the risk factors for infection with LB. Further studies are needed to fully understand the risk of infection with LB in China.

In China, Lyme borreliosis (LB) was first identified in Heilongjiang forest regions in 1986[1]. The natural foci of LB are present in at least 19 provinces of China. As a natural focus disease, LB has been intensively studied[2] particularly on its ecological characteristics, geographical spreading, and vectors in host animals. *Borrelia (B.) burgdorferi sensu lato (s.l.)* were isolated from ticks and rodents and genotyped. It was reported that *Ixodes (I.) persulcatus* is able to transmit LB[3] and plays a leading role in transmission of LB in North China, including Beijing[4]. *I. persulcatus* and *Haemaphysalis longicornis* are distributed and *B. afzelii* and *B. garinii* are isolated and genotyped in the northern suburb of Beijing[5].

On the other side, few epidemiological data of human LB are available[6-7]. It was reported in the 1990s that the antibody titer for *B. burgdorferi s.l.* is rather high in some residents of forest areas with a positive rate of 5.06% in China[6]. No harmonized diagnostic criteria for LB are available in China, and few LB patients have been confirmed by laboratory tests. The prevalence of LB in different studies is incomparable. The risk factors for infection with *B. burgdorferi s.l.* remain undefined in China. To the best of our knowledge, no study has been undertaken on the influence factors for infection with LB in China. In this case-control study, the exposure risk of residents in endemic area of LB was evaluated according to the epidemiological investigations and serologic tests.

A population-based case-control study with 34 cases and 272 controls was conducted in 28 villages of Beijing where LB is endemic. The study villages are located near to Miyun Reservoir in northern Beijing. The cases were the local farmers with positive anti-*burgdorferi* IgG tested by ELISA and Western blot, respectively. For each case, 8 controls were matched by age (±5 years from the birth date of cases) and sex. Eligible controls were defined as farmers living in the same study area for more than 3 years, with negative anti-*burgdorferi* IgG tested by ELISA and Western blot, respectively. Written informed consent was obtained from all subjects involved in this study.

The subjects were personally interviewed by

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well-trained interviewers in March and April, 2011. The information of cases and controls was collected using a standard questionnaire. The interested 4 contents were the environments, agricultural works and outdoor activities (picking, fishing, and exercise in the wild field), personal protective behaviors and knowledge about tick bite prevention. Venous blood samples were taken from each subject.

The presence of IgG antibodies against specific antigens of *B. burgdorferi s.l.* was detected by ELISA and Western blot as previously described[8]. The criteria for Western blot were established for PD91 as previously described[8]. When one or more bands of P83/100, P58, P39, P30, OspC, P17, P66, and OspA were shown, the sample was considered as positive for IgG antibodies to *B. burgdorferi s.l*.

The data set was developed using the EpiData software and statistical analysis was performed with the SAS 8.02 software. Categorical variables were expressed as percentage (n/N) and comparatively analyzed by conditional logistic regression analysis. The *B. burgdorferi* infection- associated independent correlative factors were investigated using the multivariate conditional logistic regression model. $P<0.05$ was considered statistically significant. When $P<0.05$ in univariate analysis, the variables were incorporated into the multivariate analysis.

Thirty-four cases and 272 controls included in this study were all farmers with males accounted for 47.1% in both groups. Their mean age was 53.1 and 49.8 years, respectively. No significant difference was found in sex, age, and education levels between the 2 groups (Table 1).

The relative factors in the living environments are shown in Table 2. It was taken granted that people are more easily infected with LB in mountainous regions where the density of ticks is highe[9], with *B. burgdorferi s.l.* easily isolated from ticks and rodents[5]. In the present study, the incidence of seropositive LB was higher in local farmers living in plain area than in those living in mountainous regions (OR=3.496, 95% CI: 1.438-8.499). Weeding in yard (OR=2.567, 95% CI: 1.267-5.204) also significantly increased the incidence of seropositive LB. No significant difference was found in the other factors of living environments between the 2 groups (Table 2), such as pets (dogs and cats) in households, leaf litters in yards, and houses inside or outside the village. Raising one or more kinds of animals near the house, including rabbit, pig, cattle, sheep, goat or poultry did not significantly increase the incidence of seropositive LB.

The influences of agricultural activities on the crop land were assessed (Table 3). Of the subjects, 71.2% planted winter wheat and summer-maize, 41.8% worked in orchards. Those sowing and harvesting in summer were more likely to infect with LB (OR=3.054, 95% CI: 1.383-6.743). However, no significant difference was observed in the activities in crop land such as sowing or harvesting in other seasons between the 2 groups, which is consistent with the reported farmer activities and season of tick activities[9]. The highest density of ticks was found in June in Beijing, the time for farmers to harvest winter wheat and to sow summer-maize seeds. The outdoor activities of subjects were mainly picking wild fruits (38.2%) and collecting firewood (29.7%) when the tick density was lower and did not increase the incidence of seropositive LB (Table 3). It was difficult to detect the difference in other outdoor activates such as herding, fishing, exercising and playing between the 2 groups. The season of outdoor activities was also evaluated with no significant difference found between the two groups.

Table 1. Baseline Characteristics of the Subjects Included in This Study

Variables	Case (*n*=34)		Control (*n*=272)		*P* Value
	No.	%	No.	%	
Age, years					0.161
18-	5	14.7	55	20.2	
40-	20	58.8	155	57	
60-73	9	26.5	62	22.8	
Gender					-
Male	16	47.1	128	47.1	
Female	18	52.9	144	52.9	
Education, years					0.75
≤6	12	35.3	110	40.4	
6-9	20	58.8	122	44.9	
>9	2	5.9	40	14.7	

Table 2. Risk Factors in Living Environments in this Study

Living Environments	Case (*n*=34)		Control (*n*=272)		*P* Value	OR (95% CI)
	No.	%	No.	%		
Residential location					0.006	3.496 (1.438-8.499)
mountainous regions	26	76.5	251	92.3		
plain area	8	23.5	21	7.7		
weeding in yard					0.009	2.567 (1.267-5.204)
No	14	41.2	178	65.4		
Yes	20	58.8	94	34.6		
Leaf litter in the yard					0.935	-
No	19	55.9	154	56.6		
Yes	15	44.1	118	43.4		
Pet in household					0.659	-
No	14	41.2	123	45.2		
Yes	20	58.8	149	54.8		
Raising animal*					0.843	-
No	8	23.5	60	22.1		
Yes	26	76.5	212	77.9		

Note. *dogs and cats.

Table 3. Risk Factors in Agricultural Works and Outdoor Activities in this Study

Activities	Case (*n*=34)		Control (*n*=272)		*P* Value	OR (95% CI)
	No.	%	No.	%		
Sowing in Spring					0.22	-
No.	13	38.2	77	28.3		
Yes	21	61.8	195	71.7		
Harvesting in Autumn					0.206	-
No	13	38.2	76	27.9		
Yes	21	61.8	196	72.1		
Sowing or harvesting in summer					0.006	3.054 (1.383-6.743)
No	9	26.5	144	52.9		
Yes	25	73.5	128	47.1		
Working in the greenhouse					0.023	3.289 (1.180-9.170)
No	28	82.4	255	93.8		
Yes	6	17.6	17	6.3		
Outdoor activities*					0.395	-
No	18	52.9	164	60.3		
Yes	16	47.1	108	39.7		

Note. *picking, fishing, and exercise in the wild field.

It was reported that preventive measures can reduce the risk of tick bite. Wearing long pants and clothes with collars and cuffs can decrease seropositive LB (OR=0.216, 95% CI: 0.050-0.928). No other preventive measures are used by the local farmer in Beijing. The awareness of tick bite prevention is very low. Only 48.0% of the subjects knew the existence of ticks in their living environment and crop land, only 26.2% of the subjects knew that they had been bited by ticks, only 2.3% of the subjects knew that ticks could transmit LB, and no subjects knew how to find and remove ticks on their body.

Four variables were included in the final multivariate model. Sowing or harvesting in summer (OR=2.571, 95% CI: 1.109-5.962), living in house with weeding in yard (OR=2.247, 95% CI: 1.062-4.755) and residence in plain area (OR=2.630, 95% CI: 1.050-6.588) were the independent factors for seropositive LB. Wearing long pants and clothes with collars and cuffs could prevent tick bite (OR=0.186, 95% CI: 0.041-0.846).

Few studies are available on the risk factors for the infection with LB in China. Most information regarding the risks of infection with LB is derived from the ecological distribution of ticks[3-5] or from the studies in Europe or North America where the lifestyle and habits are quite different, showing that people are easily infected with LB in plain area or in working crop land. The residents almost have little prophylactic knowledge about ticks and exposure to tick bite and LB. Further studies are needed to fully understand the risk or protective factors for infection with LB in China. The poor knowledge about ticks cannot help to prevent tick bites and LB. Greater efforts should thus made in popularizing the basic prophylactic knowledge about ticks.

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