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Exposure and preventive behaviours toward ticks and Lyme disease in Canada: Results from a first national survey

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ABSTRACT

Lyme disease (LD) risk is increasing in Canada. In 2014, the government of Canada launched a national communication campaign to raise awareness and promote the adoption of individual preventive behaviours toward ticks and LD. The objectives of this study were to evaluate and compare the adoption of LD preventive behaviours and the exposure to tick bites of Canadians in the five main targeted regions (British Columbia, Prairie provinces, Ontario, Quebec and the Atlantic provinces). A national survey was conducted in December 2014 (n = 2876) to collect data on LD awareness, behaviours and risk factors. Overall, the proportion of respondents reporting tick exposure was high (20%). The results suggest that even though LD awareness was found to be high (with only 12% of the respondents reporting that they never heard about LD), less than half of the Canadians who heard about it have adopted specific preventive behaviours toward tick bites, such as regular tick checks (reported by 52%), protective clothing (50%), using tick repellent (41%) or shower or bath (41%) after visiting a wooded area in a LD risk area. Moreover, significant differences were found between regions, gender, age groups and dog ownership status, regarding preventive behaviours and factors of exposure. A high level of knowledge of Lyme disease, living in the Prairie region, as well as having found a tick on oneself or a relative, were found to be associated with the adoption of preventive behaviours. This study underlines the importance to take into account specific regional characteristics of risk and to maintain public health communication efforts through time in order to increase the adoption of preventive behaviours of Canadians.

1. Introduction

Lyme disease (LD) is a bacterial multisystemic disease caused by *Borrelia burgdorferi* and transmitted to humans by *Ixodes* sp. ticks. In Canada, LD is an emerging disease: there were 40 reported human cases in 2004, and the annual number of cases risen to reach 917 reported cases in 2015 (Bouchard et al., 2015; Nadelman and Wormser, 1998; Ogden et al., 2014; Public Health Agency of Canada, 2016). Risk factors for LD are mostly behaviours or activities that increase the risk of exposure to tick bites. Visiting parks, the practice of outdoor activities such as gardening or hiking, and other activities that enable prolonged contact with vegetation have been associated with a positive serology for *B. burgdorferi* in case-control studies (Finch et al., 2014; Orloski et al., 1998; Smith et al., 2001). Living near a wooded area or observing deer on the property (Orloski et al., 1998; Smith et al., 2001) are also identified as peridomestic risk factors. Several studies focusing on the occupational risk for LD have shown that the probability of a positive serological test result for *B. burgdorferi* was higher among outdoor and forest workers (Piacentino and Schwartz, 2002; Richard and Oppliger, 2015).

There is no vaccine currently available against LD and existing tick control interventions aimed at reducing the entomological risk have shown variable results (Piesman and Eisen, 2008). Preventive behaviours at the individual level still remain the main strategy to prevent the transmission of *B. burgdorferi* and include wearing long trousers when visiting wooded areas, applying tick repellent, checking for and removing ticks, as well as taking a bath or a shower after visiting wooded areas during high risk periods (Finch et al., 2014; Lane et al., 1992; Malouin et al., 2003; Mowbray

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et al., 2012; Smith et al., 2001; Vazquez et al., 2008). The adoption of preventive behaviours by individuals can be influenced by multiple factors, among which are socio-cultural and demographic characteristics, level of knowledge and risk perception about the disease, and the current incidence of the disease in one region (Aenishaenslin et al., 2015; Conner, 2005; Cummings et al., 1980; Daltroy et al., 2007). These factors have been studied based on different theoretical behavioural models, including the Health Belief Model (Aenishaenslin et al., 2015, 2014). A good understanding of these factors is crucial to adapt risk communication messages to the characteristics of the targeted populations (Aenishaenslin et al., 2015, 2014).

In 2014, the Government of Canada launched a national Action Plan on Lyme Disease to raise public awareness on LD and to promote the adoption of preventive behaviours (Harymann et al., 2014). One previous study showed evidence of rapid changes in the Canadian public awareness toward ticks and LD a few months following the implementation of this communication campaign (Aenishaenslin et al., 2016a). The proportion of Canadians that never heard about LD decreased significantly, and knowledge about symptoms, transmission mode and several preventive behaviours increased in the general public (Aenishaenslin et al., 2016a). This study also revealed that these changes in awareness were not homogenous between Canadian regions (Aenishaenslin et al., 2016a). The adoption of preventive behaviours toward LD, as well as the determinants of these behaviours, have been studied previously in the United States (Armstrong et al., 2001; Brewer et al., 2004, 2004; Cartter et al., 1989; Gould et al., 2008; Hallman et al., 1995; Heller et al., 2010; Herrington et al., 1997; McKenna et al., 2004; Phillips et al., 2001; Shadick et al., 1997), and in Europe (Beaujean et al., 2013a, 2013b; de Vries and van Dillen, 2002; Mowbray et al., 2014). In Canada, past studies have evaluated knowledge, risk perceptions, preventive behaviours and acceptability of tick control interventions to prevent LD in one high risk region in the province of Quebec, the Montérégie region, in 2012, but none has studied the variability of these factors in the entire country in a comprehensive manner (Aenishaenslin et al., 2015, 2014, 2016b).

The main objectives of this study were to evaluate the level of adoption of LD preventive behaviours after the 2014 national communication campaign and to measure Canadians' exposure to tick bites, in the five Canadian regions: Quebec, Ontario, Atlantic region (Prince Edouard Island, New Brunswick, Nova Scotia and New Foundland and Labrador), the Prairie provinces (Manitoba, Saskatchewan and Alberta) and British Columbia, and among different subgroups of the population. A third objective was to identify key factors associated with a high level of adoption of preventive behaviour by individuals.

2. Material and methods

2.1. Study design

This study was cross-sectional and used data collected through a web survey conducted in December 2014 in Canada. The target population for this study consisted of individuals residing in the five studied regions. The eligibility criteria were to be 18 years or older, to be a resident of one of the five study regions and to speak French or English. Respondents were recruited randomly from a webpanel administered by Canadian polling firm SOM from 15 to 20 December 2014 (SOM, 2016). Sampling was stratified on the five Canadian regions: Quebec, Ontario, Atlantic region, the Prairie provinces and British Columbia. This protocol was reviewed and approved by the Ethical Committee for Health Research of the Université de Montréal (Certificate number 14-088-CERES-D).

2.2. Data collection

The questionnaire was developed specifically for this study, based on the theory of health behaviours (Conner, 2005) and on previous questionnaires used in Quebec, Canada, to measure LD knowledge, attitudes and behaviours (Aenishaenslin et al., 2015, 2016b). The questionnaire (Supplementary file 1), available in English and French, included questions to evaluate 1) general knowledge on LD (having heard of LD before the survey, knowledge of symptoms, disseminated LD manifestations and post-treatment health problems, existence of a treatment, knowledge of the transmission mode, and knowledge of the risk period in Canada (May to October), 2) knowledge of LD preventive behaviours, 3) risk perception of LD versus other health conditions, 4) tick exposure, 5) past experiences with LD (having consulted a doctor about LD, having had LD, knowing someone with LD) and 6) the level of adoption of ten preventive behaviours (as listed above) measured with a five-point scale ('During the last year, did you apply this measure?", options were: never, rarely, sometimes, often, always or "do not apply to my situation"). Demographic characteristics (gender, age, education level, family income) were also assessed. The questionnaire was reviewed by a committee of experts in public health and Lyme disease in Canada. The polling firm pre-tested the questionnaires using a small group of panelists to verify understanding of questions.

2.3. Data analysis

In order to facilitate interpretation of data and to reduce the number of variables included in multivariable analysis, data relative to knowledge and preventive behaviour were used to compute global scores. A global knowledge score (GKS) from 0 to 9 was computed based on the sum of scores obtained on nine main knowledge questions (one point by correct answer), including knowledge scores on five questions on health consequences of Lyme disease (on acute and post-treatment manifestations; Aenishaenslin et al., 2016a), two general knowledge questions on risk (how is Lyme disease transmitted and when is the season of greatest risk), and knowledge of the following methods of LD prevention: 1) examining yourself for ticks and removing them, 2) wearing long trousers and long-sleeved shorts ("long clothing"), 3) using insect repellents, and 4) taking a shower or a bath after activities occurring in a wooded area. A global preventive behaviour score (GPS) from 0 to 4 was also computed based on the sum scores on reported adoption of the four preventive behaviours detailed above. These four preventive behaviours were chosen to compute the GPS because they were targeted in the 2014 communication campaign in Canada (Harymann et al., 2014).

Descriptive and multivariable statistical analyses were performed using IBM SPSS Statistics 19 (IBM Corporation, Armonk, NY). For descriptive analysis, frequencies are presented unweighted, and proportions are weighted by province, gender, age and education level (except for demographic characteristics in Table 1, which are reported unweighted). Post stratification weights were computed using the 2011 Canadian census data (Statistics Canada, 2016). Pearson Chi-square statistics were calculated to assess significant differences ($p < 0.05$) between groups in descriptive statistics. Multivariable logistic regression was used to identify factors associated with a high versus low GPS (GPS ≥ 3 = high and GPS < 3 = low). For multivariable analysis, GKS was a categorical explanatory variable dichotomized as: GKS ≥ 6 = high and GKS < 6 = low. Univariate regressions were done separately for each independent variable (region of residency, GKS, tick exposure factors, having had LD, knowing someone with LD, having found a tick, perceived LD risk, having children at home, owning a dog and chosen language to fill the questionnaire). Variables associated with the