Study of general practitioner consultations for tick bites at high, medium and low incidence areas for Lyme borreliosis in England and Wales

Short running title: Tick bite consultations in England and Wales

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Summary

Lyme borreliosis (LB) is a tick-borne disease caused by *Borrelia burgdorferi* sensu lato complex. In Europe, it is predominately transmitted by the sheep tick, *Ixodes ricinus*. Compared with other European countries, the United Kingdom (UK) is considered to have a low incidence of LB, although this varies regionally. To determine whether an association exists between tick bite consultations and LB incidence in the UK, retrospective questionnaires were sent to general practitioners (GPs) in high (Wiltshire), medium (Cumbria) and low (Wales) incidence areas. During 2011, the greatest incidence of consultations for tick bites was reported by GPs in Cumbria (204 consultations per 100,000 inhabitants), followed by Wiltshire (160 per 100,000 population) and Wales (54 per 100,000 population). In Wiltshire and Cumbria, GPs predominantly provided advice on tick removal, whilst Welsh GPs mostly advised patients on tick bite prevention. Focusing on Cumbria during 2011-2013, 72.5% of GPs removed ticks from patients (incidence of 101 consultations per 100,000 population), and more GPs diagnosed LB based on clinical features than laboratory-confirmed diagnoses. To date, this is the first study to investigate the incidence of tick bite consultations and LB in England and Wales.

Keywords

Borrelia burgdorferi sensu lato; GP; incidence; *Ixodes ricinus*; tick-borne infection; UK

Impacts

- The study investigated whether an association exists between tick bite consultations and Lyme borreliosis, by sending questionnaires quantifying tick bite consultations to GPs in high, medium and low Lyme borreliosis incidence areas
- GPs from the medium Lyme borreliosis incidence areas reported the highest incidence of tick bite consultations, followed by those in the high incidence area and finally GPs in the low incidence area
- Members of the public visit their GPs for advice regarding ticks and Lyme borreliosis; by understanding whether the public seeks advice following tick bites allows public health messaging to be tailored to the public's need

Introduction

Lyme borreliosis (LB), caused by *Borrelia burgdorferi* sensu lato (s.l.) spirochetes predominantly transmitted in Europe by *Ixodes ricinus*, is the most common tick-borne infection in Europe. There is an estimated LB

incidence across Western Europe of 22.04/100,000 persons-years (Sykes and Makiello 2016), although incidence may vary locally (Letrilliart et al. 2005, Hofhuis et al. 2006, Vanthomme et al. 2012).

Whilst LB incidence in the UK is low (2.70 cases per 100,000 population) (PHE 2018), regional incidence may be higher: for example, 9.8 cases per 100,000 in southern England (Dryden et al. 2015), and 6.8 cases per 100,000 in Scotland (Mavin et al. 2015). Many LB cases are diagnosed on clinical features, such as erythema migrans (Stanek et al. 2012). Only laboratory-confirmed cases are included in national figures, yet approximately 1,000-2,000 additional LB cases are clinically-diagnosed annually and not included in national rates (PHE 2018). In the UK, LB incidence may be threefold higher than reported (Cairns et al. 2019), and anecdotal reports from Scotland suggest that only 20% of suspected cases are referred for laboratory confirmation (Evans et al. 2014, Mavin et al. 2015). National statistics, therefore, may underestimate the true infection incidence.

Despite under-reporting, LB incidence increases have occurred in several countries including the UK (Smith and Takkinen 2006, Hubálek 2009, Cairns et al. 2019, Tulloch et al. 2019), likely driven by greater awareness of symptoms, improved surveillance (Hubálek 2009), and greater tick abundance (Jaenson et al. 2012, Sprong et al. 2012). Changing distributions of ticks and hosts may lead to exposure in areas previously tick-free (Jaenson et al. 2012, Medlock et al. 2013), for example at higher altitudes due to warmer temperatures (Danielová et al. 2008). Rises in tick bite consultations in Switzerland and the Netherlands have been associated with increased tick abundance (den Boon et al. 2004, Hofhuis et al. 2006, 2015, OFSP 2016). High prevalence of *B. burgdorferi* s.l. in ticks has been associated with high human LB incidence (Stafford *et al.*, 1998; Rauter and Hartung, 2005; Beytout *et al.*, 2007; Wilhelmsson *et al.*, 2016). High disease incidence may be driven by greater tick exposure due to increased outdoor activities, lengthening of the active tick season, encroachment into tick habitats, or a combination of factors (Medlock et al. 2013).

Two studies investigating tick bite and LB incidence have been conducted in the UK: one examined tick bite risk to people utilising a forested recreational area in southern England (Robertson et al. 2000) and the second surveyed mountain marathon runners in the Scottish Highlands (Hall et al. 2017). In England and Wales, primary care is provided by GPs based in surgeries serving defined local populations; thus, GPs in high, medium and low LB incidence regions were surveyed to ascertain whether an association exists between tick bite consultations and disease incidence. The surveys also aimed to understand whether GPs were providing advice to patients following tick bites and whether GPs felt they had enough resources available to them. We then focused on an area of medium LB incidence to quantify tick removal consultations and incidence of patients diagnosed with LB over a three-year period.

Materials and Methods

Survey of GP *tick bite consultations*

Within England and Wales, over 44,000 registered GPs work in over 8,000 practices (BMA 2017). All GP practices in Wiltshire and Cumbria, and a sample of population-representative practices (GP surgeries from across Wales reflecting the demographic make-up of Wales) in Wales were invited to take part in the study. Areas were selected to represent high, medium and low LB incidence regions, respectively, based on laboratory-confirmed case incidence during the focal period (Health Protection Agency 2012). Wiltshire is based in the high incidence area (South West, 5.0/100,000 cases), Cumbria in the medium incidence area (North West, 0.52/100,000 cases) and Wales the low incidence area (0.3/100,000) (Health Protection Agency 2012). Data extraction from electronic patient records was possible, but at the time, tick bites did not have a

unique code and may have been coded under 'insect bite' or 'Lyme disease'. We wanted to capture consultations for tick bites rather than disease manifestation, so opted for GP recall-based methodology. A retrospective self-administered survey was comprised of five closed questions (Appendix 1): i) number of tick bite consultations (see Fig. 1) between January-December 2011; ii) whether patients expressed concerns about ticks; iii) type of advice being sought (e.g. tick removal/bite prevention); iv) information sources used to provide advice; v) whether further resources would assist with tick-related consultations. Invitation letters and questionnaires were sent in June 2012 to coincide with the peak of tick biting in the UK, and reminder letters were sent in September 2012. Letters were addressed to the practice, so responses may have come from one GP out of several based at that practice; we assumed that the response related to the number of consultations seen by the responding GP and would not be representative of the whole practice.

The incidence of tick bite consultations per 100,000 inhabitants was calculated using the median of each consultation category on the questionnaire. Numbers of registered patients at each GP practice in Wiltshire and Cumbria were obtained from NHS Digital and NHS England, whilst numbers for Welsh GP practices were obtained from the Quality and Outcomes Framework supplied by the Welsh Government (https://gov.wales/statistics-and-research/general-medical-services-contract/?tab=previous&lang=en). Total tick bite consultations in the three areas were divided by the number of patients registered at responding GP practices in that area and multiplied by 100,000 to generate the incidence of tick bite consultations per 100,000 population (Hofhuis et al. 2006).

Survey of GP tick removal and LB consultations

In 2014, GP practices in southern Cumbria were selected to investigate tick removal and LB consultations. Retrospective surveys were sent to 69 GPs and comprised of three questions (Appendix 2): i) numbers of patients attending the surgery for tick removal between January 2011 and December 2013; ii) numbers of patients diagnosed with LB following laboratory confirmation of a serology sample; iii) numbers of patients clinically diagnosed (no laboratory confirmation). Invitation letters and questionnaires were sent in January 2014.

Numbers of patients registered per GP practice over the focal period (January 2011-December 2013) was obtained from NHS Digital and NHS England. The incidence of consultations requiring tick removal per 100,000 inhabitants, as well as the incidence of laboratory-diagnosed and clinically-diagnosed Lyme borreliosis per 100,000 inhabitants was calculated as above.

Results

Survey of GP *tick bite consultations*

In 2012, GP practices in Wiltshire, Cumbria and Wales (n=211) were sent questionnaires, and responses were received from 77 (37%) (Figure 1). The greatest response came from Wiltshire GPs (n=30, 48.8%), followed by Wales (n=19, 42.2%) and Cumbria (n=28, 26.9%).

In total, 86.7% of GPs responding from Wiltshire reported tick bite consultations in 2011, with 85.7% from Cumbria and 63.2% from Wales. Consultation incidence was greatest in Cumbria (205 per 100,000 population) followed by Wiltshire (160 per 100,000 population) and Wales (54 per 100,000 population). The most frequently reported number of consultations for tick bites by GPs from Wiltshire (50%) was 5-14 consultations, whilst Cumbrian (38.5%) and Welsh (55.6%) GPs most frequently reported 1-4 consultations (Fig. 2). One GP surgery from Wiltshire and two surgeries from Cumbria reported more than 50 consultations during the focal period, whilst the maximum number of consultations by GPs in Wales was 15-24 (Fig. 2). In

addition, 13.3% of GPs in Wiltshire, 14.3% in Cumbria and 36.8% in Wales did not have any patient consultations for tick bites (Fig. 2).

In Wiltshire, 67% of responders reported that their patients had expressed concern about ticks during 2011, compared with 61% in Cumbria and 53% in Wales. In all three regions, GPs provided information to patients on tick removal, bite prevention and tick biology, risk areas and LB symptom recognition (Fig. 3), with more Wiltshire GPs advising on symptom recognition (Fig. 3), and Cumbrian GPs providing more advice on tick removal, bite prevention, risk areas and tick biology, than GPs in the two other areas (Fig. 3).

Almost 60% of GPs gave advice based on personal experiences of ticks. Only two responders (7.1%) from Cumbria gave advice from a professional training course. Whilst 22.1% of all responders used the Health Protection Agency (HPA, now Public Health England) website, twice as many GPs (44.2%) used other websites, and 19.5% used other information sources. In total, 36.7% of Wiltshire GPs, 32.1% from Cumbria and 26.3% from Wales, (mean=32.5%) thought that extra resources would assist consultations.

Survey of GP tick removal and LB consultations

In January 2014, GPs (n=69) in southern Cumbria were sent questionnaires; responses were received from 40 (57.9%; Fig. 1). In total, 72.5% of GPs reported tick removal consultations between 2011 and 2013 (three GPs [7.3%] did not quantify consultation numbers); 24.4% of GPs reported 1-4 and 5-14 consultations, 9.8% reported 15-24 consultations, and 7.3% reported 25-49 consultations. Tick removal consultation incidence was 101 per 100,000 population. Across the region, 52.5% of GPs diagnosed patients with LB following laboratory confirmation, with an incidence of 21 cases per 100,000 population, whilst 57.5% of GPs diagnosed LB clinically (no laboratory confirmation), with an incidence of 31 cases per 100,000 population.

Discussion

During 2011, the greatest incidence of tick bite consultations was reported by GPs in Cumbria (medium LB incidence), followed by Wiltshire (high incidence) and Wales (low incidence). Cumbrian GPs provided the most advice on tick removal, bite prevention, risk areas and tick biology, whilst Wiltshire GPs advised more patients on symptom recognition. We might have expected the most consultations to come from Wales, because people living in low LB incidence regions may not be as familiar or confident with tick removal, so may visit GPs more regularly, whereas those living in high or even medium incidence regions may encounter ticks more frequently and may be confident in removing ticks from themselves (Hofhuis et al. 2015). The high consultation numbers reported by Wiltshire and Cumbria GPs suggest this was not the case; instead there may be fewer ticks biting residents in Wales than the other regions.

Patients in all three areas visited GPs for advice as well as tick removal, which was highlighted by the second Cumbrian survey where tick removal consultation incidence (101 consultations per 100,000 population incidence) was lower than tick bite consultation incidence in the same region (204 per 100,000 population). There are several resources available to GPs to support public health advice delivery, including specialist websites, training courses and more publicly available information. Whilst a third of GPs thought extra resources would assist consultations, there are now greater resources available than when the surveys were conducted, including the National Institute for Health and Care Excellence (NICE) guidelines for diagnosing and managing LB (https://www.nice.org.uk/guidance/ng95).

Over 50% of responding GPs reported tick bite prevention enquiries. Many studies have demonstrated that *B. burgdorferi* (s.l.) spirochetes are transmitted after a period of attachment, depending on the tick life stage and genospecies of *B. burgdorferi* s.l. (des Vignes et al. 2001, Piesman et al. 2001, Crippa et al. 2002, Cook 2015). Carrying out thorough body and clothing checks for ticks, ensuring prompt removal, and recognising the signs and symptoms of LB, will greatly reduce infection risk or complications (Jones et al. 2002, Due et al. 2013, Cull et al. 2019). Despite this, however, the uptake of tick bite prevention behaviours among the public remains low (Cartter et al. 1989, Jones et al. 2002, Mowbray et al. 2014) as precautionary behaviours such as walking on pathways or wearing long-sleeved tops and trousers are considered inconvenient or intrusive of outdoor activities (Marcu et al. 2011). Members of the public are more likely to adopt post-tick exposure precautionary behaviour than pre- or during-visit behaviours (Marcu et al. 2013).

In Cumbria (medium incidence), fewer GPs diagnosed patients via laboratory-confirmed tests (52.5%) compared with diagnoses based on clinical symptoms (57.5%). In the Scottish Highlands, an estimated 20% of suspected LB cases are referred for testing (Evans et al. 2014, Mavin et al. 2015), and UK incidence may be higher than previously reported (Cairns et al. 2019). Indeed, NICE guidelines state that patients presenting with EM should be treated empirically, and laboratory testing is not recommended. Diagnosing LB can be difficult as many of the symptoms are non-specific, such as fatigue, headache and arthralgia, and symptom frequency reported by patients with suspected LB were no different to those reported by a control group (Cerar et al. 2010).

Here, GPs in a medium LB incidence region reported the highest consultations for tick bites, compared with high and low LB incidence areas. In all areas, GPs provided patients with tick and LB advice. The study could be repeated and extended to GP practices nationally to gain a better understanding of the

incidence of tick bites across the UK to better understand the risk posed in the UK and target public health advice accordingly. By better understanding where the public go for advice in response to tick bites, public health messaging can be tailored to improve prevention, awareness and action following tick bites.

Conflict of interest statement

The authors declare that there is no conflict of interest.

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Figures

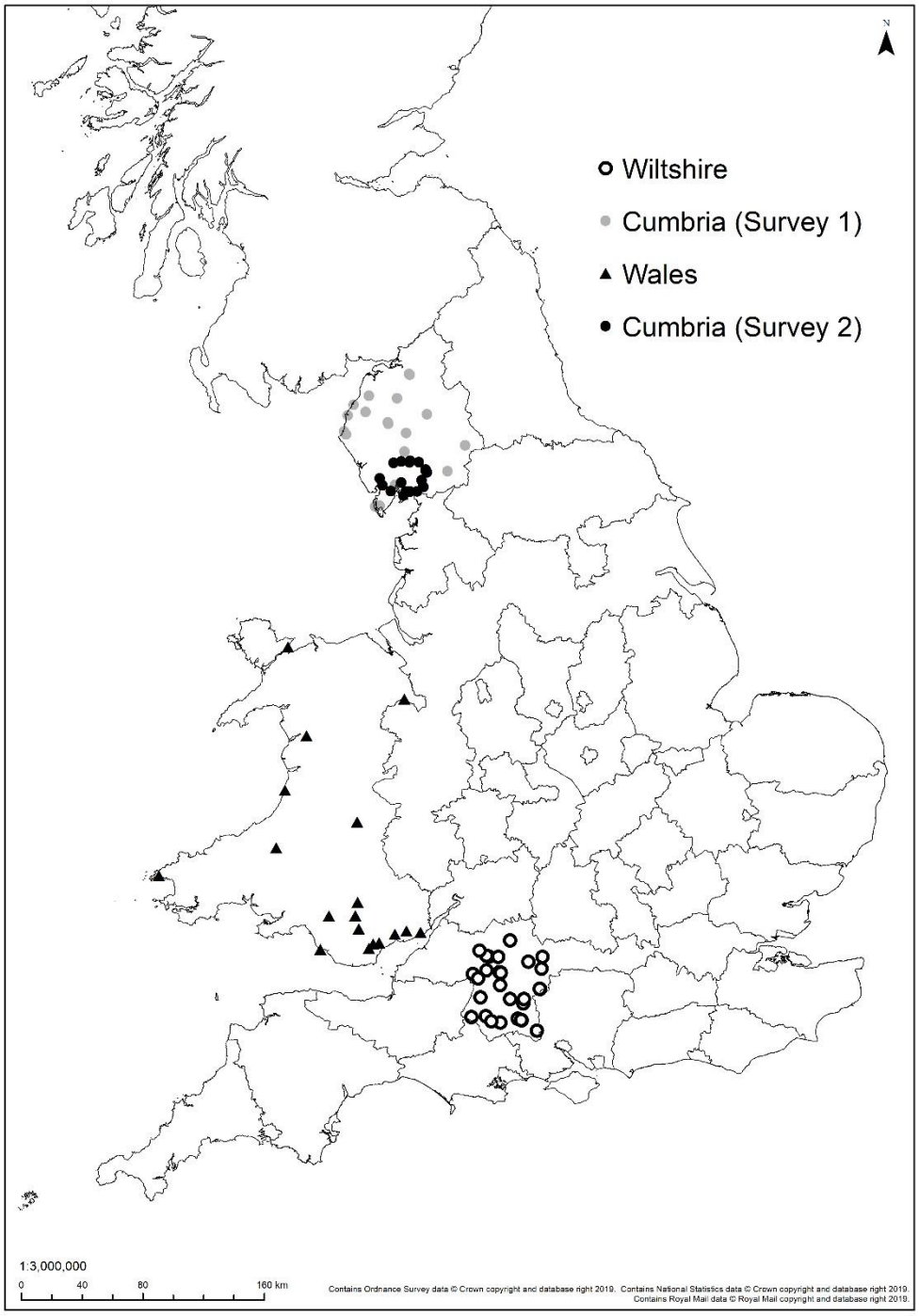

Figure 1 Map of locations of GP practices in Wiltshire (open circles), Cumbria (grey (2011) and black circles (2011-2013)) and Wales (black triangles) that responded to questionnaires regarding tick bite consultations

355 Figure 2 Percentage of GPs reporting the number of consultations for tick bites in Wiltshire (black),
356 Cumbria (dark grey) and Wales (light grey) in 2011

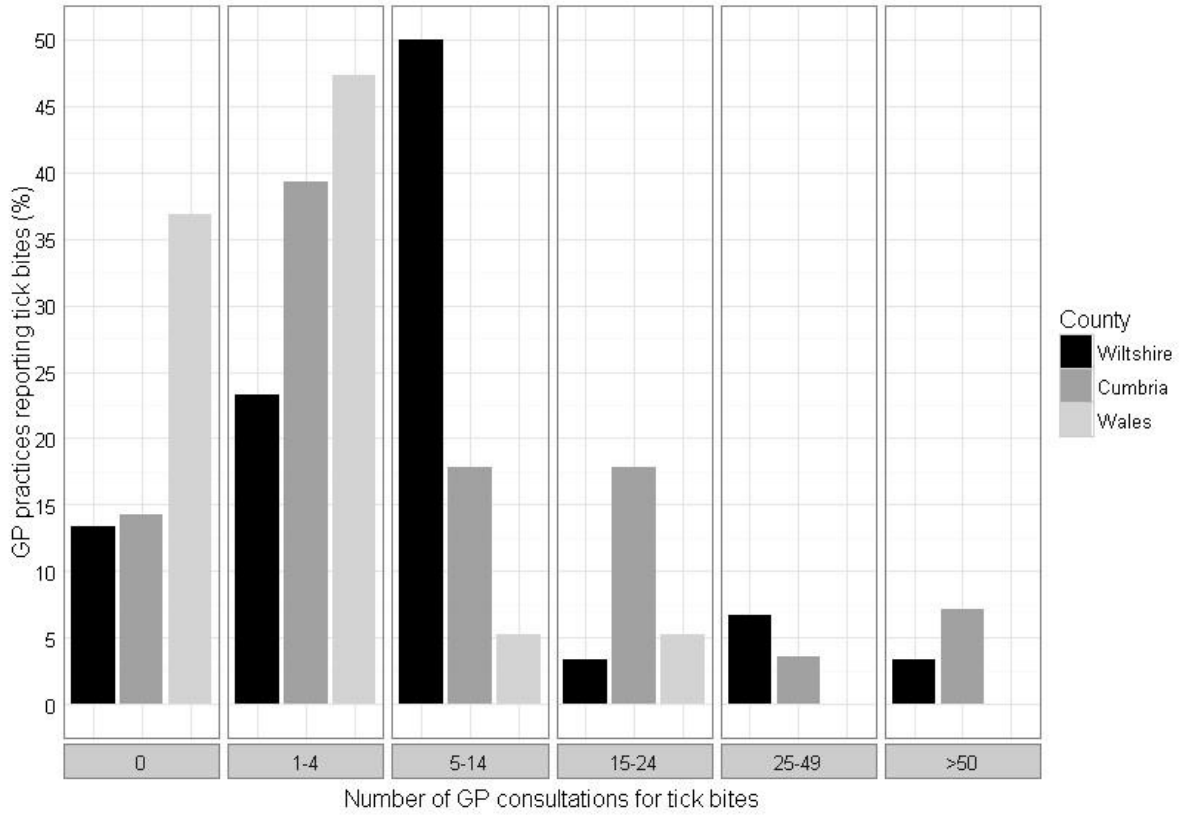

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Figure 3 Percentage of GPs that provided advice to patients on tick removal, tick bite prevention, tick risk areas, tick biology and symptom recognition in Wiltshire (black), Cumbria (dark grey) and Wales (light grey) during 2011