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# Lyme borreliosis awareness and risk perception: a survey in 20 European countries

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## Abstract

An estimated 129000 cases of Lyme borreliosis (LB) are reported annually in Europe. In 2022, we conducted a representative web-based survey of 28034 persons aged 18–65 years old in 20 European countries to describe tick and LB risk exposures and perceptions. Nearly all respondents (95.0%) were aware of ticks (range, 90.4% in the UK to 98.8% in Estonia). Among those aware of ticks, most (85.1%) were also aware of LB (range, 70.3% in Switzerland to 97.0% in Lithuania). Overall, 8.3% of respondents reported a past LB diagnosis (range, 3.0% in Romania to 13.8% in Sweden). Respondents spent a weekly median of 7 (interquartile range [IQR] 3–14) hours in green spaces at home and 9 (IQR 4–16) hours away from home during April–November. The most common tick prevention measures always or often used were checking for ticks (44.8%) and wearing protective clothing (40.2%). This large multicountry survey provided needed data that can be used to design targeted LB prevention programmes in Europe.

## Introduction

Lyme borreliosis (LB), a bacterial infection caused by various genospecies of the *Borrelia burgdorferi* sensu lato complex, is transmitted to humans through the bite of infected *Ixodes* spp. ticks. LB is the most common tick-borne disease in Europe [1] with an estimated ~129000 cases reported annually from the 25 European countries with LB surveillance systems; an estimated 24% of the population of Europe resides in areas of high LB incidence (annual LB incidence of >10 cases per 100000 population per year) [2]. Countries with the highest surveillance-reported incidence (>100 cases/100000 population per year) include Estonia, France, Lithuania, Poland, Slovenia, and Switzerland; however, incidence can markedly vary within a country [2]. LB is an important public health concern as its incidence in Europe continues to increase and risk areas are expanding [3].

LB is acquired when humans come into contact with infected, biting ticks, typically as a result of exposures via outdoor activities in endemic areas. Although *Ixodes ricinus* ticks, the primary vector in Europe, are historically associated with forested areas, changes in land and wildlife management have resulted in established populations with a high prevalence of B. burgdorferi infection in urban and suburban areas across Europe [4]. A recent review of 115 studies published during 1990–2021 found substantial evidence of Borrelia spp. infected *I. ricinus* in urban green spaces in 24 European countries [5]. Data from humans are limited, but a study of nearly 3000 participants in Poland reported similar LB seropositivity for persons residing in rural areas versus in a city [6], and another reported a similar, increasing incidence of LB among urban and rural residents across the country [7]. In addition, a study in Finland found that a measure of human activity-weighted infection risk was higher in urban green spaces than rural areas as a result of increased opportunities for human-tick contact in urban areas [8], highlighting the possible exposure risk for LB in green spaces in urban areas. Thus, it is important for persons residing in urban areas to understand their risk for LB and to take appropriate prevention measures when engaging in outdoor activities.

The current cornerstone of LB prevention relies on the use of self-protection measures, including avoiding tick habitats, wearing protective clothing, using repellents targeted at ticks and other arthropods ('insect repellents'), and conducting tick checks [9]. However, these measures have limited real-world effectiveness as they are typically practiced inconsistently, in part, because individuals might not perceive themselves at risk for disease. Increasing uptake of prevention measures, including potential future vaccines, requires understanding what people know and believe about the disease and how they perceive their own personal risk. Although there have been some studies reporting on LB knowledge and practices in individual European countries or subnational regions [6, 10–18], comprehensive data about the general population's knowledge, tick exposure, risk perception, and prevention practices towards LB in Europe are lacking. Detailed, systematically collected data that are comparable across countries are needed to better describe the epidemiology of LB in Europe and ultimately to inform the design and targeting of prevention programmes.

Thus, the objective of this study was to describe knowledge about LB and the prevalence of LB risk exposures and perceptions in 20 European countries, overall, by country and by urbanicity (e.g. urban, suburban, and rural).

## Methods

### *Study design*

We conducted an online cross-sectional survey of adults aged 18–65 years in 20 European countries during November 2022–January 2023 (Figure 1). Countries were chosen for inclusion in the study based on their documented burden of LB; the final selection of countries also depended on local regulations that allowed for conducting surveys. The sampling frame was derived from existing nonprobability-based consumer survey panels maintained by Ipsos GmbH. Ipsos GmbH programmed and hosted the survey and


**Figure 1.** Twenty countries included in multi-country Lyme borreliosis survey in Europe, 2022; the number of respondents (n) and the survey response rate (%) in each country is noted below the country name.

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recruited and compensated respondents. Compensation was provided in the local currency or other incentives in accordance with the panels' established protocols and norms.

A final sample size of 27400, with a range of 1000 to 2650 respondents in each country was targeted to achieve representative estimates for key variables of interest with a margin of error of plus or minus 3% using a confidence level of 95%. Based on prior knowledge of panel response rates, 271747 invitations to survey panelists were needed to achieve this sample. Country-specific sample sizes and recruitment quotas were derived from age group, gender, and regional distributions (based on nomenclature of territorial units for statistics [NUTS] levels 1, 2, or 3 depending on the country). Data for quotas and data weighting (described below) were obtained from Eurostat (https://ec.europa.eu/Eurostat; all countries except the United Kingdom) and the Office of National Statistics (www.ons.gov.uk; for the United Kingdom).

## *Survey*

The ~15-minute web-based survey included questions about LB awareness, risk perception, and disease history (n=18 questions), tick awareness and history of tick bites (n=9), LB vaccination intention and factors influencing intention (n=7), the amount of time and number of activities outdoors in green spaces near and away from home (n=5), use of prevention measures (n=2), general attitudes towards health care providers and vaccines (n=3), and demographics (n=11) (Table S1). Questions were derived from existing surveys, where possible. Questions on risk perception, concern, and disease severity were scaled from 1 to 5, with 1 indicating very low risk or strong disagreement and 5 indicating very high risk or strong agreement. The survey instrument was translated into the local language(s) for each country. A quantitative pilot test of the survey was conducted in Germany and the UK with n=250 respondents per country.

The survey questions were preceded with a description of the voluntary nature of the survey, the respondent's right to withdraw at any point, an agreement about provision of health data, and a notice of privacy policies; respondents were asked to check boxes indicating their understanding and agreement before proceeding to the questions. The survey was considered exempt from institutional review board oversight by the principal investigator in accordance with categories of exempt research under 45 CFR part 46.104, Exempt Research [19] .

## *Analysis*

Quality checks of completed surveys were conducted to identify and exclude responses from respondents who had straight line responses, who answered certain sets of questions (e.g., time, frequency) with the same values, who had clear signs of speeding or providing random answers, or whose interview length was shorter than the average * 0.33.

Random iterative method weighting [20] using age group, gender, and country region as input variables was used to weight the final dataset. Individual weights were created first for each country, and then, the individual country weights were used as pre-weights for the entire dataset using population size as the input to achieve global weighting. All analyses were performed on the weighted dataset.

For analyses of perceived risk of LB, concern about LB, and LB severity, we analysed the proportion of respondents with a 'high' level, which was defined as persons who selected answer choices four or five. For analyses of variables reporting time spent on outdoor activities, upper-bound outliers, defined as quartile 3 + 1.5 * interquartile range, were not included in the analysis. Urbanicity was categorized based on self-reported residence in a city (urban), in the suburbs of a city/outlying residential district of a city (suburban), or in the countryside (rural).

We calculated frequencies with 95% confidence intervals to describe demographic characteristics and measures of LB perception and medians with interquartile ranges (IQR) to report measures of activity time and duration. For responses with missing values, the denominator for analysis included only respondents who answered that particular question. Chi-square and t-tests were used for categorical variables and continuous variables, respectively, to evaluate statistically significant differences between groups [21]. All analyses were performed using R Statistical Software (R version 4.3.2; R Core Team 2023) using the R survey package (version 4.2, Lumley 2023) to account for the survey design and weighting. Significance was considered a p-value < 0.05 and/or the presence of non-overlapping confidence intervals. Survey results were reported according to a consensus-based checklist for reporting survey studies (Table S2) [22].

# Results

## *Sample selection and characteristics*

Of 271747 invitations sent to survey panelists, 65561 persons clicked into their unique invitation link and initiated the survey, and 28834 completed it. After removing 800 (2.8%) responses that

**Table 1.** Weighted and unweighted Lyme borreliosis (LB) multicountry survey respondent demographics from twenty countries in Europe, 2022. Estimates were weighted by country region, gender, and age

| Characteristic | Unweighted N=28034 (100%) | Weighted N = 28034 (100%) |
|---|---|---|
| **Gender** | | |
| Female | 14231 (50.8%) | 13926 (49.7%) |
| Male | 13696 (48.9%) | 14026 (50.0%) |
| Other | 61 (0.2%) | 55 (0.2%) |
| Prefer not to answer | 46 (0.2%) | 27 (<0.1%) |
| **Age group (years)** | | |
| 18–29 | 6261 (22.3%) | 6306 (22.5%) |
| 30–39 | 6294 (22.5%) | 6042 (21.6%) |
| 40–49 | 6265 (22.3%) | 5972 (21.3%) |
| 50–65 | 9214 (32.9%) | 9714 (34.7%) |
| **Years of education** | | |
| 9–10 years | 3818 (13.6%) | 4479 (16.0%) |
| 11–13 years | 11698 (41.7%) | 11158 (39.8%) |
| ≥ 14 years | 12518 (44.7%) | 12397 (44.2%) |
| **Has ≥ 1 child** | 13430 (47.9%) | 13303 (47.5%) |
| **Urbanicity** | | |
| Urban | 14305 (51.0%) | 13610 (48.5%) |
| Suburban | 6793 (24.2%) | 7555 (26.9%) |
| Rural | 6936 (24.7%) | 6869 (24.5%) |

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did not pass quality checks, 28034 completed surveys (Figure 1, Table 1) remained in the analysis dataset. The overall response rate, calculated as the final number of completed surveys after removing poor-quality responses divided by the total number of initiated surveys, was 42.8%, with response rates ranging from 27.7% in the UK to 70.7% in the Czech Republic (Figure 1) [23].

Weighted and unweighted demographics characteristics of respondents are shown in Table 1. About half of respondents (49.7%) were female, 34.7% were ages 50-65 years old, 44.2% had 14 or more years of education, and 47.5% had a child living in their household. About half (48.5%) of respondents resided in urban areas, 26.9% resided in suburban areas, and 24.5% in rural areas. Respondents from urban areas were younger than respondents from suburban and rural areas and were more likely to be male, to have ≥14 years of education, and to have a child in the household (Table S1).

### *Tick and LB Awareness*

Nearly all respondents (95.0%, 95% confidence interval [CI:]: 94.6–95.4%) were aware of ticks with a range by country from 90.4% in the UK (95% CI: 89.0–92.0%) to 98.8% in Estonia (95% CI: 97.9–99.0%) (Figure 2). Almost all respondents from rural settings (97.6%, 95% CI: 97.1–98.0%) were aware of ticks, followed by suburban (95.2%, 95% CI: 94.5–95.9%) and urban respondents (93.6%; 95% CI: 93.0–94.2%), respectively (Table S1). Among those aware of ticks, most (85.1%, 95% CI: 84.5–86.0%) were also aware of LB, with a range by country from 70.3% (95% CI: 67.7–73.0%) in Switzerland to 97.0% (95% CI: 95.8–98.0%) in Lithuania and by urbanicity from 88.3% (95% CI: 87.2-89.3%) among rural respondents to 82.5% (95% CI: 81.6–83.4%) among urban respondents.

About half (51.1%, 95% CI: 50.2–52%) of respondents reported having ever been bitten by a tick, with variation by country from 28.4% (95% CI: 26.2–30.7%) in the United Kingdom to 91.2% (95% CI: 89.6%–92.6%) in the Czech Republic (Table 2). Respondents from rural areas were most likely to report ever being bitten by a tick (55.1% compared with 48.8% urban, 43.1% suburban; Table S1). Among respondents having ever been bitten by a tick, 61.7% reported a tick bite in the past year. Overall, 8.3% (95% CI: 7.8–8.8%) of respondents reported a past LB diagnosis confirmed by a doctor, with a range by country from 3.0% (95% CI: 2.8–4.2%) in Romania to 13.8% (95% CI: 12.2–15.6%) in Sweden. Urban respondents were most likely to report that a doctor had diagnosed them with LB in the past (11.4% compared with 5.8% suburban, 5.5% rural; Table S3); however, rural respondents were more likely to report knowing someone with a past LB diagnosis.

### *Risk perception*

Among the 22202 respondents who were aware of ticks and LB, 32.0% (95% CI: 31.2–32.8%) reported a high perceived risk of contracting LB, with a range from 21.7% (95% CI: 18.89–24.8%) in Denmark to 52.6% (95% CI: 49.8–55.4%) in Lithuania. Overall, 42.9% (95% CI: 42.0–43.8%) of respondents reported a high level of concern about contracting LB, with a range from 28.5% (95% CI: 25.7–31.4%) in Austria to 75.9% (95% CI: 73.4–78.3%) in Lithuania. Most (79.3%, 95% CI: 78.6–80.0%) considered LB to be a severe disease, with a range from 68.5% (95% CI: 65.5–71.4%) in Austria to 89.8% (95% CI: 88.1–91.2%) in Poland (Table 2). Respondents with a past LB diagnosis were most likely to report a high perceived risk of contracting LB (76.4%, 95% CI: 73.8–78.8%), to have a high concern about contracting LB (76.2%, 95% CI: 73.6–78.6%), and to consider LB a severe disease (84.6%, 95% CI: 82.4–86.5%) (Table S4). Risk perception and concern about contracting LB were generally highest among urban respondents compared with suburban and rural respondents, except among respondents with a past LB diagnosis where urban and rural respondents had similar risk perception (Table S4). Overall, urban respondents were more likely than suburban and rural respondents to consider LB a severe disease; however, there were no differences in perception of disease

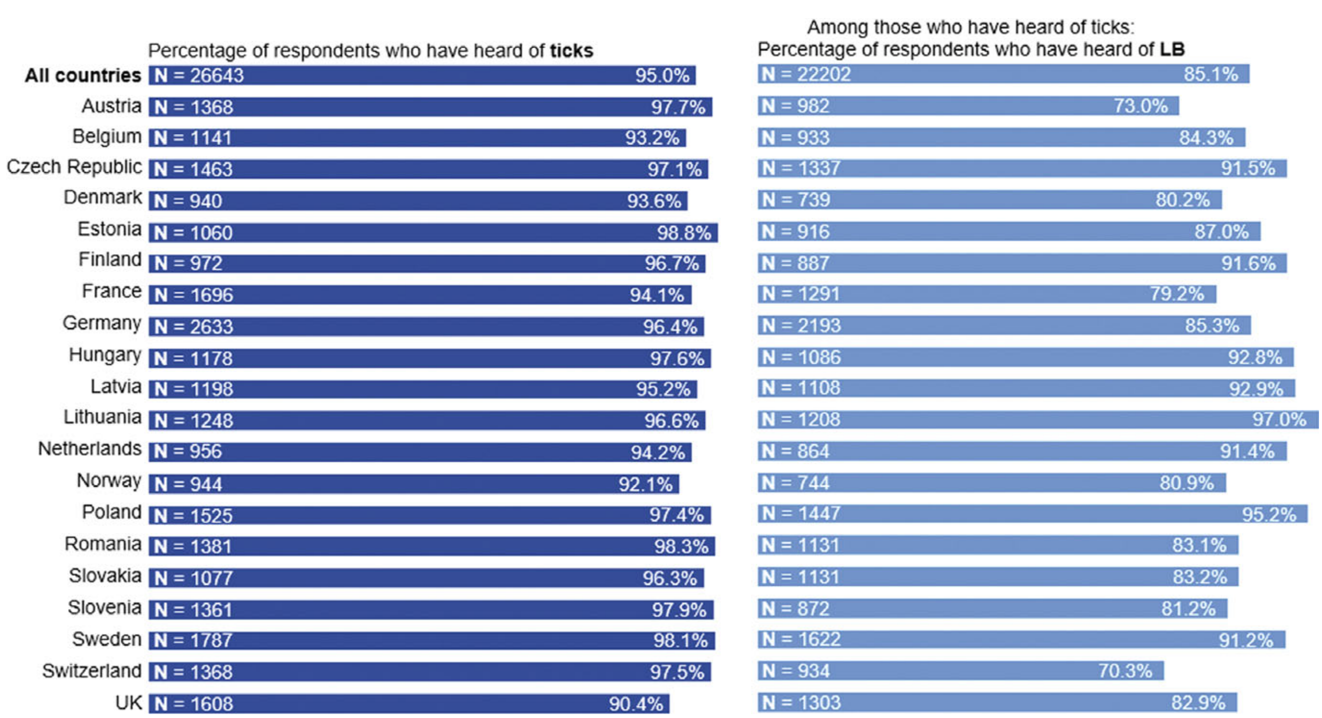


**Figure 2.** Reported tick and Lyme borreliosis (LB) awareness, stratified by country, as reported in a multi-country Lyme borreliosis survey in Europe, 2022.

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**Table 2.** Lyme borreliosis (LB) multicountry survey results by country: Proportions of past tick bite, past LB diagnosis, high perceived risk of LB, high concern about LB, and perception of LB severity, twenty countries in Europe, 2022; respondent bases and estimates shown have been weighted by country region, gender, and age

| Country | Ever bitten by a tick[a] | Past LB diagnosis confirmed by a doctor[b] | Reported a high perceived risk of contracting LB[b], [c] | Reported a high concern about contracting LB[b,c] | Considers LB to be a severe disease[b,c] |
|---|---|---|---|---|---|
| | | | N, % (95% CI) | | |
| All countries | 11342, 51.1% (50.2% – 52.0%) | 1843, 8.3% (7.8% – 8.8%) | 7106, 32.0% (31.2% – 32.8%) | 9520, 42.9% (42.0% – 43.8%) | 17603, 79.3% (78.6% – 80.0%) |
| Austria | 973, 72.3% (69.8% – 74.6%) | 115, 11.7% (9.8% – 13.8%) | 263, 26.7% (24.0% – 29.6%) | 279, 28.5% (25.7% – 31.4%) | 673, 68.5% (65.5% – 71.4%) |
| Belgium | 356, 32.1% (29.4% – 35.0%) | 79, 8.5% (6.8% – 10.4%) | 230, 24.6% (22.0% – 27.5%) | 361, 38.7% (35.6% – 41.9%) | 702, 75.2% (72.3% – 77.9%) |
| Czech Republic | 1332, 91.2% (89.6% – 92.6%) | 141, 10.6% (9.0% – 12.3%) | 413, 30.9% (28.5% – 33.4%) | 469, 35.1% (32.6% – 37.7%) | 1015, 75.9% (73.5% – 78.1%) |
| Denmark | 475, 51.5% (48.3% – 54.8%) | 73, 9.9% (7.9% – 12.2%) | 160, 21.7% (18.8% – 24.8%) | 235, 31.7% (28.5% – 35.2%) | 588, 79.6% (76.5% – 82.3%) |
| Estonia | 724, 68.8% (65.9% – 71.6%) | 68, 7.4% (5.8% – 9.3%) | 331, 36.2% (33.1% – 39.4%) | 402, 43.9% (40.6% – 47.2%) | 683, 74.6% (71.6% – 77.3%) |
| Finland | 376, 38.9% (35.8% – 42.0%) | 57, 6.4% (5.0% – 8.2%) | 232, 26.1% (23.3% – 29.1%) | 286, 32.2% (29.2% – 35.4%) | 715, 80.6% (77.9% – 83.1%) |
| France | 675, 41.4% (39% – 43.8%) | 98, 7.6% (6.3% – 9.1%) | 384, 29.7% (27.3% – 32.3%) | 595, 46.0% (43.3% – 48.8%) | 1074, 83.2% (81.1% – 85.1%) |
| Germany | 1499, 58.3% (56.4% – 60.2%) | 198, 9.0% (7.9% – 10.3%) | 725, 33.1% (31.1% – 35.1%) | 837, 38.2% (36.1% – 40.2%) | 1731, 79.0% (77.2% – 80.6%) |
| Hungary | 714, 61.0% (58.2% – 63.8%) | 59, 5.4% (4.2% – 6.9%) | 276, 25.4% (22.9% – 28.1%) | 381, 35.1% (32.3% – 37.9%) | 764, 70.4% (67.6% – 73.0%) |
| Latvia | 900, 75.5% (73% – 77.9%) | 93, 8.4% (6.9% – 10.3%) | 388, 35.1% (32.3% – 38.0%) | 687, 62.0% (59.0% – 64.8%) | 857, 77.3% (74.8% – 79.7%) |
| Lithuania | 923, 74.1% (71.6% – 76.5%) | 101, 8.3% (6.9% – 10.0%) | 635, 52.6% (49.8% – 55.4%) | 917, 75.9% (73.4% – 78.3%) | 915, 75.8% (73.3% – 78.1%) |
| Netherlands | 336, 35.5% (32.5% – 38.6%) | 71, 8.2% (6.6% – 10.2%) | 263, 30.4% (27.5% – 33.6%) | 334, 38.7% (35.5% – 42.0%) | 698, 80.8% (78.0% – 83.3%) |
| Norway | 483, 52.5% (49.3% – 55.8%) | 80, 10.8% (8.8% – 13.2%) | 187, 25.2% (22.1% – 28.4%) | 293, 39.4% (35.9% – 43.0%) | 546, 73.4% (70.1% – 76.5%) |
| Poland | 931, 61.2% (58.7% – 63.6%) | 109, 7.5% (6.3% – 9.0%) | 717, 49.6% (47% – 52.1%) | 916, 63.3% (60.8% – 65.7%) | 1299, 89.8% (88.1% – 91.2%) |
| Romania | 517, 37.9% (35.4% – 40.6%) | 34, 3.0% (2.8% – 4.2%) | 340, 30.1% (27.5% – 32.8%) | 680, 60.1% (57.2% – 62.9%) | 998, 88.2% (86.2% – 89.9%) |
| Slovakia | 1,039, 76.4% (74.1% – 78.6%) | 80, 7.1% (5.7% – 8.7%) | 346, 30.6% (28.0% – 33.3%) | 464, 41.0% (38.2% – 43.9%) | 885, 78.2% (75.7% – 80.5%) |
| Slovenia | 933, 86.9% (84.7% – 88.9%) | 73, 8.4% (6.7% – 10.4%) | 360, 41.3% (38.0% – 44.8%) | 421, 48.3% (44.8% – 51.7%) | 696, 79.8% (76.9% – 82.4%) |
| Sweden | 1217, 68.4% (66.2% – 70.5%) | 224, 13.8% (12.2% – 15.6%) | 509, 31.4% (29.2% – 33.7%) | 619, 38.2% (35.8% – 40.6%) | 1116, 68.8% (66.5% – 71.0%) |
| Switzerland | 686, 51.6% (48.9% – 54.3%) | 81, 8.7% (7.04% – 10.7%) | 253, 27.0% (24.3% – 30.0%) | 312, 33.4% (30.4% – 36.5%) | 734, 78.6% (75.8% – 81.1%) |
| United Kingdom | 445, 28.4% (26.2% – 30.7%) | 115, 8.8% (7.36% – 10.5%) | 330, 25.3% (23.0% – 27.8%) | 449, 34.5% (31.9% – 37.1%) | 941, 72.2% (69.7% – 74.6%) |

[a]Measured among tick-aware respondents.
[b]Measured among tick- and LB-aware respondents.
[c]Questions were asked on a five-point scale from least to greatest; respondents answering with a 4 or 5 were considered to have a high perceived risk of LB, be highly concerned about LB, or consider LB to be a severe disease.

severity by urbanicity among respondents with a history of a tick bite or past LB diagnosis (Table S2).

### *Use of protection measures*

Overall, 67.5% (95% CI: 66.7–68.0%) of respondents who were aware of ticks reported always or often wearing protective clothing, using insect repellent, avoiding tick-infested areas, or checking for ticks after spending time outside. The most common tick prevention measure reported was always or often checking for ticks after spending time outdoors (45.7%; 95% CI: 44.9–46.5; Table 3), followed by always or often wearing protective clothing (41.8%; 95% CI: 41.0–42.6%), with some variations by country (Table S5). Insect repellent was the prevention measure respondents most often reported never using (31.4%; 95% CI: 30.6–32.2%).

### *Outdoor time and activities*

Respondents spent a median of 7 (IQR: 3–14) hours outdoors on their property and 9 (IQR: 4–16) hours outdoors away from home each week during April–November (Table 4). Overall, respondents who reported spending time outdoors as part of their primary occupation, spent a median of 7 (IQR 4–14) hours each week. Respondents with children reported that their children spent a median of 7 (IQR 3–14) hours outdoors each week. On average, respondents spent a median of 12 (IQR 5–24) hours hunting or fishing during April through November and a median of 17 (IQR 9–30) days camping, wilderness backpacking, or away from regular home in areas with forests, woods, parks, or tall grasses during April through November. Although there was considerable variable by country, respondents from Slovenia tended to report more time spent on outdoor activities and respondents from Belgium tended to report less time spent on outdoor activities (Table 4).

## Discussion

This is the first comprehensive multicountry survey about awareness and risk perception of LB conducted among adults aged 18–65 years in Europe, providing valuable insights into attitudes and practices related to ticks and LB prevention. Overall, survey respondents in these 20 European countries were aware of ticks and LB and considered LB to be a severe disease. Respondents reported spending a considerable amount of time outdoors in forests, woods, parks, tall grass, or on their property during April-November, the peak months for tick activity and *Borrelia burgdorferi* sensu latu transmission, highlighting the substantial exposure risk for residents of areas in Europe where LB is endemic and the continued need for measures to prevent LB. Variations by country and urbanicity also illustrate areas where education and prevention efforts are needed.

Our results generally align with those of earlier studies of LB conducted in single European countries or subnational regions. Similar to prior surveys, most respondents were aware of ticks [24] or had heard of LB [12, 24] and tended to regularly spend time outdoors [24]. Across multiple prior studies [6, 12, 15-17, 24], respondents commonly reported ever having a tick bite, with a range from 30% in France [12] to 87.3% in the Czech Republic [24], and 6% (in a region of Switzerland) to 11% (Sweden) reported previously having LB [15, 25]. The current study extends these findings by providing updated, representative estimates that are comparable across countries, as well as estimates for countries with no prior data.

These results further highlight the growing risk for LB in urban green spaces in Europe [4, 5]. For example, urban respondents reported the highest prevalence of a past LB diagnosis, and were generally more likely to perceive themselves to be at risk and to express a high level of concern for LB compared with rural and suburban respondents. An earlier study conducted in Poland found that urban and rural residents reported comparable tick bite prevalence [6]; in contrast, a survey in France found that the proportion of individuals with a history of a tick bite was highest for persons living in rural compared with urban areas [12]. We did not have the data to know where individuals who reported a past LB diagnosis acquired their infection; however, acquisition of LB via travel to endemic areas also likely contributed to some proportion of the cases reported among urban residents and respondents living in lower incidence areas of included countries.

The level of disease endemicity in an area can also influence disease perception and the use of prevention measures. Evidence from both the US and Europe has found that people living in high-incidence areas have a lower perception of Lyme disease severity [26] and that people who spend less time in high-incidence areas are more likely to use protective measures [27, 28]. These prior results are consistent with our own findings that urban residents had a higher risk perception for LB and were somewhat more likely to always or often use prevention measures. Similarly, although respondents in Romania, which has a low surveillance-reported LB incidence [2], had the lowest prevalence of reporting a past LB diagnosis, respondents from Romania had a higher perception of disease severity than respondents from Sweden, who reported the highest prevalence of past LB diagnosis. More generally, perceptions about LB and familiarity with ticks and tick-borne diseases likely reflect the influence of a range of factors, including prior experiences with ticks and tick-borne diseases, socioeconomic

**Table 3.** Reported tick prevention use among tick-aware respondents with known prevention use frequency from a multi-country survey in Europe, 2022; estimates and respondent bases shown have been weighted by country region, gender, and age

| Prevention Measure | N | Always or often | Sometimes or seldom | Never |
|---|---|---|---|---|
| | | | n (95% CI) | |
| Wears protective clothing, (e.g., long socks, or tucks trouser legs into socks) | 25390 | 10610, 41.8% (41.0%–42.6%) | 10334, 40.7% (39.9%–41.5%) | 4446, 17.5% (16.9%–18.2%) |
| Uses insect repellent such as DEET | 25007 | 7261, 29.0% (28.3%–29.8%) | 9899, 39.6% (38.8%–40.4%) | 7847, 31.4% (30.6%–32.2%) |
| Avoids tick-infested areas | 24360 | 9681, 39.7% (38.9%–40.6%) | 10731, 44.1% (43.2%–44.9%) | 3948, 16.2% (15.6%–16.8%) |
| Checks for ticks after spending time outside | 25395 | 11601, 45.7% (44.9%–46.5%) | 9268, 36.5% (35.7%–37.3%) | 4526, 17.8% (17.2%–18.5%) |
| Other | 13852 | 3280, 23.7% (22.7%–24.6%) | 7210, 52.0% (50.9%–53.2%) | 3362, 24.3% (23.3%–25.3%) |

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**Table 4.** Reported time[a] spent on activities that take place in forests, woods, parks, tall grass, or outdoors between April 1 and November 30 by type of activity, overall and stratified by country; results weighted by country region, gender, and age

| Category | Outdoors at home[b] | Outdoors away from home[c] | Occupation[d] | Child outdoor activity[e] | Fishing and hunting[f] | Outdoor trips[g] |
|---|---|---|---|---|---|---|
| Country | | | N, median (IQR) | | | |
| Total | 28034, 7 (3–14) | 28034, 9 (4–16) | 18744, 7 (4–14) | 12566, 7 (3–14) | 2183, 12 (5–24) | 9678, 17 (9–30) |
| Austria | 1400, 8 (4–15) | 1400, 10 (5–17) | 839, 7 (4–14) | 513, 8 (4–15) | 85, 10 (4–20) | 353, 17 (10–34) |
| Belgium | 1224, 5 (2–10) | 1224, 7 (3–12) | 796, 5 (3–10) | 551, 5 (2–10) | 75, 11 (5–23) | 313, 15 (7–32) |
| Czech Republic | 1506, 8 (2–15) | 1506, 10 (5–19) | 924, 9 (4–16) | 697, 10 (4–16) | 59, 11 (5–18) | 598, 21 (12–41) |
| Denmark | 1005, 7 (3–12) | 1005, 10 (4–16) | 633, 5 (3–10) | 405, 5 (2–12) | 111, 14 (6–24) | 272, 17 (8–30) |
| Estonia | 1073, 8 (3–15) | 1073, 10 (5–17) | 716, 8 (4–15) | 481, 7 (3–15) | 57, 16 (9–24) | 420, 13 (8–22) |
| Finland | 1006, 7 (3–12) | 1006, 8 (4–14) | 713, 6 (3–10) | 459, 6 (3–11) | 101, 16 (8–52) | 320, 17 (8–32) |
| France | 1803, 6 (2–10) | 1803, 7 (3–13) | 1312, 5 (3–10) | 954, 4 (2–10) | 156, 14 (6–25) | 817, 18 (9–32) |
| Germany | 2733, 7 (3–14) | 2733, 8 (4–15) | 1389, 6 (3–14) | 977, 7 (3–14) | 151, 6 (4–15) | 647, 17 (9–30) |
| Hungary | 1207, 8 (3–14) | 1207, 8 (4–15) | 854, 8 (4–15) | 510, 8 (3–14) | 82, 8 (5–16) | 439, 14 (7–26) |
| Latvia | 1259, 10 (3–17) | 1259, 11 (5–20) | 829, 8 (4–14) | 565, 8 (4–15) | 115, 17 (8–33) | 520, 12 (7–22) |
| Lithuania | 1292, 9 (3–18) | 1292, 10 (5–19) | 873, 10 (5–20) | 656, 8 (3–18) | 69, 12 (6–29) | 566, 18 (10–30) |
| Netherlands | 1015, 7 (3–12) | 1015, 10 (5–16) | 643, 6 (3–14) | 407, 5 (2–11) | 73, 9 (4–20) | 188, 13 (7–25) |
| Norway | 1025, 8 (4–14) | 1025, 10 (5–17) | 696, 7 (4–14) | 453, 6 (3–14) | 179, 15 (5–31) | 508, 21 (11–40) |
| Poland | 1565, 8 (3–14) | 1565, 10 (5–19) | 1189, 8 (4–15) | 822, 8 (3–15) | 89, 9 (4–23) | 359, 23 (10–48) |
| Romania | 1405, 9 (3–15) | 1405, 10 (5–18) | 1077, 8 (5–15) | 650, 10 (4–15) | 119, 16 (5–36) | 891, 18 (10–30) |
| Slovakia | 1414, 7 (3–14) | 1414, 8 (3–15) | 976, 5 (3–10) | 659, 5 (2–10) | 76, 11 (4–28) | 465, 21 (9–44) |
| Slovenia | 1100, 10 (5–16) | 1100, 11 (5–19) | 856, 10 (5–15) | 547, 8 (4–15) | 81, 10 (4–21) | 253, 20 (10–36) |
| Sweden | 1821, 8 (4–15) | 1821, 10 (5–17) | 1400, 8 (4–14) | 831, 8 (4–15) | 187, 14 (6–24) | 776, 16 (9–29) |
| Switzerland | 1403, 6 (3–11) | 1403, 8 (4–14) | 963, 5 (3–10) | 545, 6 (3–10) | 111, 13 (6–28) | 553, 15 (8–27) |
| United Kingdom | 1778, 7 (3–12) | 1778, 7 (3–14) | 1066, 8 (4–14) | 884, 6 (3–10) | 216, 13 (5–24) | 478, 14 (7–25) |

[a]Results do not include upper-bound outliers, defined as: *Third quartile + 1.5 * Interquartile range.*
[b]Hours spent outdoors on property per week. Outdoor at home activities included on survey were gardening, mowing the lawn, reading/sunbathing, and other.
[c]Hours spent outdoors away from home per week. Outdoor away from home activities included on survey were bird watching, hiking/running/biking, picnicking/grilling/eating outdoors, walking a dog, and other.
[d]Hours spent per week doing outdoor activities as part of primary occupation(s) (work, school, or volunteering), among respondents reporting >0 occupation hours.
[e]Hours spent per week by children under the age of 18 doing outdoor activities, among respondents with ≥1 child.
[f]Total hours spent fishing or hunting, among respondents reporting > 0 fishing and hunting trips.
[g]Total days spent camping, wilderness backpacking, or outdoors away from regular home, among respondents reporting >0 outdoor trips.

status, and access to healthcare that vary within and among countries and by urbanicity.

Given the known limitations of current prevention methods and their inconsistent use, the results from this survey illustrate the need for efficacious LB prevention methods that will be consistently used [29]. Among the prevention methods included in the survey, no single measure was always or often used by more than half of respondents, and about two-thirds of respondents reported always or often using at least one prevention measure (wearing protective clothing, using insect repellent, avoiding tick-infested areas, or checking for ticks after spending time outside). Conducting tick checks was the most common prevention approach that respondents reported always or often using, and repellents the least common, a finding that has been reported in other studies [6, 10–17]. Tick checks might be preferred because they are zero cost, and do not involve the use of chemicals, which some studies have suggested is an important consideration for the uptake of tick bite prevention methods [12]. Prior studies in the US have also provided evidence that perceptions of severity and levels of concern about tick bites are associated with use of protective measures [26, 30].

Surveys have inherent limitations and the online mode of administration through an established survey panel could have resulted in selection and participation biases; data were not available to compare the demographics of respondents who completed the survey with those who did not respond to the invitation or dropped out. Quotas and data weighting were used to help mitigate these biases, and the large sample size for each country helped ensure the robustness of these estimates. Some responses, such as the time spent on specific activities, could be subject to recall bias and might have been difficult for participants to estimate. Social desirability bias, particularly around activities like use of prevention measures, might also have influenced the results, although the web-based mode of administration might have mitigated this bias [31]. In addition, although respondents were asked to estimate their duration and frequency of outdoor activities, the actual risk associated with the specific activities is unknown, resulting in possible misclassification of exposure. Because of the large sample size, many findings are statistically significant even though the point estimate differs by only a few percentage points; the real-world significance of these differences should be considered in light of local epidemiology and LB incidence. In addition, because of difficulties in obtaining a sufficient sample of older adults the survey was limited to adults <65 years old, and the risk perceptions of older adults, a population with high rates of LB, might differ from adults of other ages. Because of how the questionnaire was structured, some questions were asked only of respondents who responded affirmatively that they knew about ticks and LB, and these respondents do not necessarily have the same risk perception of those who reported not knowing about ticks or LB. Similarly, it is possible that people who had experience with ticks and LB were more likely to respond to the survey, possibly leading to an overestimate of the knowledge and awareness of these topics., Finally, the use of a standard questionnaire across 20 countries provides an opportunity to compare countries across Europe, although it is possible questions were understood differently depending on the language and cultural context of administration.

Because the risk for LB is nuanced and there are regional variations in LB risk within countries, as well as substantial variations in LB incidence among the countries included in the survey, further analyses by country and urbanicity are needed to better elucidate country-specific risk factors and prevention needs. This includes studies to better understand behaviours related to the use of prevention methods and analyses to describe the factors that contribute to LB risk perception.

The findings from this multicountry survey set a baseline for future follow-up surveys and provides needed, actionable data to describe knowledge and practices around ticks and LB in these 20 European countries. Residents of high-incidence areas, regardless of whether they live in urban or rural areas, should continue to improve the consistent use of personal protection measures to prevent LB.

**Supplementary material.** The supplementary material for this article can be found at http://doi.org/10.1017/S0950268825000068.

**Data availability statement.** The data that support the findings of this study are available from the corresponding author, LHG, upon reasonable request.

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