The burden of Lyme borreliosis expressed in disability-adjusted life years

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Background: Lyme borreliosis (LB) is the most commonly reported tick-borne infection in Europe and North America. In the last 15 years a 3-fold increase was observed in general practitioner consultations for LB in the Netherlands. To support prioritization of prevention and control efforts for LB, we estimated its burden expressed in Disability-Adjusted Life Years (DALYs). Methods: We used available incidence estimates for three LB outcomes: (i) erythema migrans (EM), (ii) disseminated LB and (iii) Lyme-related persisting symptoms. To generate DALYs, disability weights and duration per outcome were derived using a patient questionnaire including health-related quality of life as measured by the EQ-5D. Results: We estimated the total LB burden for the Netherlands in 2010 at 10.55 DALYs per 100,000 population (95% CI: 8.80–12.43); i.e. 0.60 DALYs for EM, 0.86 DALYs for disseminated LB and 9.09 DALYs for Lyme-related persisting symptoms. Per patient this was 0.005 DALYs for EM, 0.113 for disseminated LB and 1.661 DALYs for a patient with Lyme-related persisting symptoms. In a sensitivity analysis the total LB burden ranged from 7.58 to 16.93 DALYs per 100,000 population. Conclusions: LB causes a substantial disease burden in the Netherlands. The vast majority of this burden is caused by patients with Lyme-related persisting symptoms. EM and disseminated Lyme have a more modest impact. Further research should focus on the mechanisms that trigger development of these persisting symptoms that patients and their physicians attribute to LB.

Introduction

Lyme borreliosis (LB) is caused by Borrelia burgdorferi sensu lato which in Europe is predominantly transmitted by the tick Ixodes ricinus. LB is the most commonly reported tick-borne infection in Europe and North America.1,2 The severity of symptoms in some LB patients, and the in recent years reported increase of LB in some countries or areas in Europe and North America has raised questions about its public-health impact.1–4 In the last 15 years in the Netherlands a 3-fold increase was observed in general practitioner (GP) consultations for tick bites and erythema migrans (EM)—the most frequent early LB manifestation.5,6 Early uncomplicated infection generally responds well to antibiotic treatment, and thus the majority of LB patients have a good prognosis.1,2,9,12–14 However, even after repeated antibiotic therapy, some patients report persisting symptoms like musculoskeletal pain, neurocognitive symptoms and fatigue.1,2,8,9 Especially these persisting and sometimes disabling symptoms have great impact on the quality of life of the patients concerned.

Until now, worldwide no quantitative estimation of the disease burden of LB has been available that can be used to prioritize prevention and control efforts. Such an estimate would show which LB outcomes contribute most to the LB burden, and would make it possible to compare its burden to the public-health impact of other diseases. This study aimed to estimate the burden of LB expressed in Disability-Adjusted Life Years (DALYs), a summary measure of disease burden that aggregates the impact of mortality and morbidity in one figure.10 Within the scope of this study we assessed the burden for the Netherlands in 2010; we also present the burden per case to facilitate estimates for other endemic countries based upon their national incidence figures.

Methods

Outcomes of LB and annual incidence per outcome

Figure 1 shows the possible health outcomes of LB, after a tick bite causing a Borrelia burgdorferi sensu lato infection. We distinguished three outcome categories similar as in Hofhuis et al.11: (i) EM—the most common clinical manifestation—an expanding skin lesion at the site of the tick bite; (ii) (early and late) disseminated LB—the more serious manifestations—which can present as a multi-system disease with skin, neurological, cardiac and musculoskeletal manifestations, especially if early infection remains untreated1; and (iii) persisting symptoms that patients and their physicians attribute to LB after a successfully treated infection or due to persistent infection,1,2,9,12–14 hereafter referred to as ‘persisting symptoms’.

We used a recent estimate of the LB incidence for our estimation of disease burden. In Hofhuis et al.11, the 2010 incidence per LB outcome has been estimated for the Netherlands based on a survey among GPs: per 100,000 population 131.5 (95% CI: 127.1–136.0) diagnoses of EM, 7.7 (7.2–8.2) diagnoses of disseminated LB and 5.5 (5.1–5.8) new diagnoses with persisting symptoms which the GP attributed to LB; these estimates include only (very) likely diagnoses and have been adjusted for reporting bias.11
Appendix B for further details.

15 '6–12 months', '1–5 year', '5–10 year'). To enable calculation of

the manifestations diagnosed, as reported in the questionnaire. We

firstly assigned patients to 10 manifestations of LB based upon

 Disease classification of patients

A total of 949 patients responded, of whom 660 patients were

included in the analysis; they were assigned to the outcomes EM

\( n = 88 \); of which 87 (99%) enrolled through their physicians),
disseminated Lyme \( n = 96; 88 \) (92%) enrolled through physicians)
or persisting symptoms \( n = 476; \) of which 189 (40%) enrolled

through physicians). See Appendix A and figure A1 for further
details.

Severity, duration of disease and DALYs

No meaningful survival curve could be obtained for the Lyme-
related persisting symptoms outcome because the parameter

estimates of the survival distribution had very wide confidence
intervals, as many participants in this group were still ill when
they filled in the questionnaire (i.e. most individuals had a
censored duration). Therefore, we used the censored estimate for
the mean duration for this particular outcome—i.e. 4.6 years, similar to the 3–6 years reported in earlier studies.9,18

Table 2 shows the disability weights, duration of disease and DALYs per LB outcome in the Netherlands in 2010 for the baseline estimate. The total burden due to LB was estimated at 10.55 DALYs per 100 000 population (95% CI: 8.80–12.43) and thus for the entire 16.6 million population at 1749 DALYs (95% CI: 1458–2060). For EM, we estimated the lowest disease burden per patient—i.e. a disability weight of 0.047, disease duration 5 weeks, and thus 0.005 DALYs per patient—reflecting its relatively mild condition. Because of the relatively high EM incidence, the total disease burden due to EM was nevertheless 0.60 DALYs per 100 000 population (and 99 DALYs for the total population). For disseminated LB the disease burden of 0.113 DALYs per patient was 23 times higher, reflecting its more severe condition, with a disability weight of 0.262 and disease duration of 22.5 weeks. Yet, because of the lower incidence compared with EM, the total disease burden due to disseminated LB was only 1.4 times higher: 0.86 DALYs per 100 000 population (143 for the total population). The outcome persisting symptoms had the highest disease burden per patient: an average disability weight of 0.364, disease duration 4.568 years, and thus 1.661 DALYs per patient. Although the incidence of persisting symptoms is lower than the incidence of disseminated LB, this high disease burden per patient leads to the highest disease burden per outcome: 9.09 DALYs per 100 000 population (1506 for the total population). This accounts for 86% of the total DALYs due to LB.

Sensitivity analysis

Table 2 and figure 2 show the disease burden per LB outcome for the baseline and the seven scenarios in the sensitivity analysis. The total burden due to LB ranges from 7.58 DALYs (scenario 3) to 16.93 DALYs (scenario 1) per 100 000 population. The high estimate in scenario 1, which included patients enrolled upon their own request, is mainly due to a significantly higher disease duration of these patients compared with the patients enrolled through physicians (ANOVA; P < 0.0001). In scenario 4, differences in disability weights and disease duration were not significant between patients with and without co-morbidity (ANOVA: P = 0.08 and P = 0.87).

In all scenarios, the outcome persisting symptoms is the biggest contributor to the total disease burden—ranging from 76–91% of total DALYs by LB. All scenarios showed the per patient disease burden to be highest for persisting symptoms and lowest for EM.

Discussion

We assessed the disease burden expressed in DALYs of Lyme borreliosis, the most commonly reported tick-borne infection in Europe and North America. Using available incidence estimates from Hofhuis et al.11 and a patient questionnaire to assess severity and duration of disease, we estimated the burden due to LB in the Netherlands. The total disease burden for 2010 was 10.55 DALYs per 100 000 population (95% CI: 8.80–12.43) and thus for the entire population 1749 DALYs (95% CI: 1458–2060). The vast majority of this burden due to LB was caused by patients with persisting symptoms attributed to LB (9.09 out of 10.55 DALYs per 100 000 pop.; i.e. 86%), whereas EM and disseminated LB have a more modest impact of 1.46 DALYs (0.60 and 0.86 DALYs per 100 000 pop.). Per individual LB case, the DALY estimate was also highest for persisting symptoms attributed to LB (1.661 DALYs per patient), moderately high for disseminated LB (0.113) and modest for EM (0.005).

We thus found a substantial disease burden due to LB, which calls for continued prevention and control efforts. However, its major impact is caused by patients with persistent Lyme-related symptoms, whereas both in Europe and North America it remains debated to what extent persisting symptoms attributed to LB are actually due to a present or preceding infection.1,2,12,19–21 Our patient questionnaire and the incidence survey applied by Hofhuis et al.11 cannot discriminate whether LB actually caused the reported Lyme-related persisting symptoms. Nevertheless, our results reflect the very substantial disease burden due to persisting symptoms that patients and their physicians attribute to LB. This calls for further research to the causal mechanisms of developing these symptoms—whether or not due to past or present Borrelia infection—to be able to develop better prevention and treatment strategies for patients at risk for persistence of symptoms.
Table 2: Estimation of disease burden of LB in the Netherlands 2010: baseline estimate and sensitivity analysis

<table>
<thead>
<tr>
<th>Scenario</th>
<th>LB outcome</th>
<th>Enrollment</th>
<th>Disability weight (95% CI)^a</th>
<th>Duration of disease in years (95% CI)^b</th>
<th>DALY per patient (95% CI)^c</th>
<th>Annual numbers (16.6 million pop.)^d</th>
<th>Annual incidence per 100000^e (95% CI)^f</th>
<th>DALYs per 16.6 million pop. (95% CI)^g</th>
<th>DALYs per 100 000 population (95% CI)^h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline estimate</td>
<td>EM</td>
<td>(n = 87)</td>
<td>0.047 (0.033–0.064)</td>
<td>0.096 (0.072–0.130) i.e. 5.0 wks (3.7–6.8)</td>
<td>0.0050 (0.003–0.007)</td>
<td>21802 (21064–22 545)</td>
<td>131.5 (127.1–136.0)</td>
<td>9961 (148)</td>
<td>0.60 (0.37–0.89)</td>
</tr>
<tr>
<td></td>
<td>Disseminated Lyme</td>
<td>(n = 88)</td>
<td>0.262 (0.205–0.325)</td>
<td>0.432 (0.304–0.656) i.e. 22.5 wks (15.8–34.1)</td>
<td>0.113 (0.072–0.178)</td>
<td>1268 (1186–1353)</td>
<td>7.7 (7.2–8.2)</td>
<td>143 (91–223)</td>
<td>0.86 (0.55–1.34)</td>
</tr>
<tr>
<td></td>
<td>Persisting symptoms</td>
<td>(n = 189)</td>
<td>0.364 (0.326–0.397)</td>
<td>4.568 (3.919–5.234)</td>
<td>1.66 (1.372–1.967)</td>
<td>905 (845–966)</td>
<td>5.5 (5.1–5.8)</td>
<td>1506 (1226–1796)</td>
<td>9.09 (7.40–10.84)</td>
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<tr>
<td></td>
<td>All LB</td>
<td>1749 (1458–2060)</td>
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<tr>
<td>1. Include patients enrolled upon their own request</td>
<td>EM</td>
<td>(n = 88)</td>
<td>0.047 (0.033–0.065)</td>
<td>0.097 (0.074–0.131) i.e. 5.0 wks (3.7–6.8)</td>
<td>0.0050 (0.003–0.007)</td>
<td>21802 (21064–22 545)</td>
<td>131.5 (127.1–136.0)</td>
<td>10064 (151)</td>
<td>0.60 (0.39–0.91)</td>
</tr>
<tr>
<td></td>
<td>Disseminated Lyme</td>
<td>(n = 96)</td>
<td>0.270 (0.218–0.328)</td>
<td>0.422 (0.298–0.609)</td>
<td>0.114 (0.075–0.170)</td>
<td>1268 (1186–1353)</td>
<td>7.7 (7.2–8.2)</td>
<td>145 (95–219)</td>
<td>0.87 (0.57–1.32)</td>
</tr>
<tr>
<td></td>
<td>Persisting symptoms</td>
<td>(n = 476)</td>
<td>0.385 (0.362–0.408)</td>
<td>7.337 (6.793–7.966)</td>
<td>2.826 (2.528–3.119)</td>
<td>905 (845–966)</td>
<td>5.5 (5.1–5.8)</td>
<td>2561 (2247–2876)</td>
<td>15.45 (13.56–17.35)</td>
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<td></td>
<td>All LB</td>
<td>2806 (2488–3151)</td>
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<tr>
<td>2. Include less likely LB diagnoses in incidence estimates</td>
<td>EM</td>
<td>(n = 87)</td>
<td>0.047 (0.033–0.064)</td>
<td>0.096 (0.072–0.130) i.e. 5.0 wks (3.7–6.8)</td>
<td>0.0050 (0.003–0.007)</td>
<td>21802 (21064–22 545)</td>
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<td>905 (845–966)</td>
<td>5.5 (5.1–5.8)</td>
<td>1892 (1540–2256)</td>
<td>11.41 (9.29–13.61)</td>
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<tr>
<td></td>
<td>All LB</td>
<td>2147 (1788–2530)</td>
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<tr>
<td>3. Exclude 5% patients with highest disease severity and duration</td>
<td>EM</td>
<td>(n = 66)</td>
<td>0.036 (0.025–0.048)</td>
<td>0.081 (0.064–0.101) i.e. 5.0 wks (3.7–6.8)</td>
<td>0.0030 (0.002–0.004)</td>
<td>21802 (21064–22 545)</td>
<td>131.5 (127.1–136.0)</td>
<td>6339 (92)</td>
<td>0.38 (0.23–0.56)</td>
</tr>
<tr>
<td></td>
<td>Disseminated Lyme</td>
<td>(n = 68)</td>
<td>0.217 (0.169–0.270)</td>
<td>0.332 (0.237–0.466)</td>
<td>0.0720 (0.047–0.111)</td>
<td>1268 (1186–1353)</td>
<td>7.7 (7.2–8.2)</td>
<td>9259 (142)</td>
<td>0.55 (0.36–0.86)</td>
</tr>
<tr>
<td></td>
<td>Persisting symptoms</td>
<td>(n = 158)</td>
<td>0.337 (0.304–0.371)</td>
<td>3.615 (3.189–4.049)</td>
<td>1.218 (1.019–1.425)</td>
<td>905 (845–966)</td>
<td>5.5 (5.1–5.8)</td>
<td>1101 (913–1309)</td>
<td>6.64 (5.1–7.90)</td>
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<td></td>
<td>All LB</td>
<td>1256 (1067–1474)</td>
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<tr>
<td>4. No co-morbidity</td>
<td>EM</td>
<td>(n = 39)</td>
<td>0.053 (0.025–0.085)</td>
<td>0.082 (0.054–0.124) i.e. 5.0 wks (3.7–6.8)</td>
<td>0.0040 (0.002–0.008)</td>
<td>21802 (21064–22 545)</td>
<td>131.5 (127.1–136.0)</td>
<td>9340 (171)</td>
<td>0.56 (0.24–1.03)</td>
</tr>
<tr>
<td></td>
<td>Disseminated Lyme</td>
<td>(n = 40)</td>
<td>0.237 (0.160–0.316)</td>
<td>0.353 (0.223–0.604)</td>
<td>0.0840 (0.042–0.147)</td>
<td>1268 (1186–1353)</td>
<td>7.7 (7.2–8.2)</td>
<td>106 (54–191)</td>
<td>0.64 (0.32–1.15)</td>
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(continued)
Table 2 Continued

<table>
<thead>
<tr>
<th>Scenario</th>
<th>LB outcome</th>
<th>Enrollment</th>
<th>Disability weight (95% CI)**</th>
<th>Duration of disease in years (95% CI)**</th>
<th>DALY per patient (95% CI)**</th>
<th>Annual numbers (16.6 million pop.)</th>
<th>Annual incidence per 100 000 (95% CI)**</th>
<th>DALYs per 16.6 million pop. (95% CI)**</th>
<th>DALYs per 100 000 population (95% CI)**</th>
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<tr>
<td></td>
<td>Persisting symptoms (n=75)</td>
<td>0.329 (0.280–0.387)</td>
<td>4.706 (3.583–6.164)</td>
<td>1.547 (1.118–2.077)</td>
<td>905 (845–966)</td>
<td>5.5 (5.1–5.8)</td>
<td>1402 (998–1888)</td>
<td>8.46 (6.02–11.39)</td>
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<td></td>
<td>All LB</td>
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<td></td>
<td>5. Five annual deaths due to LB</td>
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<td>9.09 (7.40–10.84)</td>
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<td></td>
<td>Assumed nr of Deaths n/a</td>
<td>1</td>
<td>47.62 (i.e. mean 47.62 yrs life expectancy for mean 39 yrs of age)</td>
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<td></td>
<td>All LB</td>
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<td>6. Adjust for censored disease duration in the persisting symptoms patients.</td>
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<tr>
<td></td>
<td>Persisting symptoms (n=189)</td>
<td>0.364 (0.326–0.397)</td>
<td>5.708 (4.897 6.541)</td>
<td>2.075 (1.714–2.459)</td>
<td>905 (845–966)</td>
<td>5.5 (5.1–5.8)</td>
<td>1882 (1532–2245)</td>
<td>11.3 (9.24–13.54)</td>
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<td></td>
<td>All LB</td>
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<td>7. Combine scenario 2, 3, 4, 5 &amp; 6</td>
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<td></td>
<td>EM (n=28)</td>
<td>0.027 (0.011–0.046)</td>
<td>0.065 (0.047 0.090)</td>
<td>0.002 (0.001–0.004)</td>
<td>21802 (21064–22 545)</td>
<td>131.5 (127.1–136.0)</td>
<td>40 (14–77)</td>
<td>0.24 (0.08–0.47)</td>
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<tr>
<td></td>
<td>Disseminated Lyme (n=36)</td>
<td>0.196 (0.130–0.271)</td>
<td>0.301 (0.191 0.485)</td>
<td>0.060 (0.030–0.115)</td>
<td>1386 (1296–1479)</td>
<td>8.4 (7.82–8.92)</td>
<td>83 (42–158)</td>
<td>0.50 (0.25–0.95)</td>
<td></td>
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<tr>
<td></td>
<td>Persisting symptoms (n=66)</td>
<td>0.314 (0.266–0.365)</td>
<td>4.589 (3.783 5.455)</td>
<td>1.445 (1.085–1.854)</td>
<td>1137 (1061–1214)</td>
<td>6.9 (6.40–7.32)</td>
<td>1644 (1227–2122)</td>
<td>9.92 (7.40–12.80)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Assumed nr of Deaths n/a</td>
<td>1</td>
<td>47.62 (i.e. mean 47.62 yrs life expectancy for mean 39 yrs of age)</td>
<td></td>
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<tr>
<td></td>
<td>All LB</td>
<td></td>
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</tr>
</tbody>
</table>

For each scenario in the sensitivity analysis the table shows the included disability weights, the duration of disease and DALY estimates based on the annual incidence per LB outcome. 
*We estimated 95% CIs using a bootstrap procedure with 1000 iterations while including missing values; for all 660 included patients an (uncensored) duration of illness had been recorded; 51 had missing values for disability weights (12 for EM, 6 for disseminated Lyme and 33 for persisting symptoms).
**For EM and disseminated patients the uncensored duration of disease was estimated using survival analysis, for the persisting symptoms patients we used the mean censored duration of disease.
This is to our knowledge worldwide the first DALY estimate for LB; it adds to other studies estimating the burden of infectious diseases, and facilitates LB burden estimates for endemic countries in Europe and North-America based upon our DALY estimates per case and their national incidence figures. Compared with many non-communicable diseases, the LB burden is limited—like for most infectious diseases especially in western countries.22–24 Nevertheless the burden of LB, as for many infectious diseases, can be decreased by public-health measures focusing on prevention of pathogen transmission and timely treatment of infection, and would likely increase without such measures. This calls for continuous priority setting in public-health.

The current study shows that in the Netherlands LB has the 12th highest disease burden, compared with the comprehensive DALY estimates for 32 other infectious diseases largely based upon the ‘Burden of Communicable Disease in Europe’ (BCoDE) project25,26,27; LB is preceded by hepatitis C and Q-fever, and followed by norovirus and Salmonella spp, with a somewhat lower burden. If we restrict our estimate to the disease burden attributed to EM and disseminated Lyme (together 1.46 DALYs per 100 000 pop.), LB has still the 20th highest burden, preceded by hepatitis B and H. influenzae, and followed by Shigella spp. and Listeria spp.

In addition, DALYs per case can also be used to compare disease burden at the individual level. Per case, the burden of Lyme-related persisting symptoms is the 11th highest compared with the 32 above mentioned pathogens, preceded by tuberculosis and Listeria spp., and followed by hepatitis B and tetanus. Disseminated LB and EM have the 19th and 31st highest disease burden respectively.

Finally, disability weights per disease can be used to compare the severity of diseases. Our disability weights based upon the patient questionnaire are within the range of the Global Burden of Disease (GBD) study 2010 disability weights for acute episodes and post-acute consequences of infectious diseases.28 For EM and disseminated LB the disability weights are very similar to the GBD disability weights for respectively moderate and severe episodes of acute infectious diseases. Lyme-related persisting symptoms and the GBD disability weight for post-acute consequences of infectious disease have overlapping confidence intervals (the GBD point estimate is 30% lower). Compared with non-infectious chronic diseases, our disability weight for Lyme-related persisting symptoms is somewhat higher than Crohn’s disease and moderate Parkinson’s disease, and somewhat lower than moderate multiple sclerosis and a moderate episode of a major depression.28

In our sensitivity analysis, the high impact due to Lyme-related persisting symptoms was consistent in all scenarios. Patients who enrolled in the study on their own request (scenario 1) clearly had a higher disease burden than patients enrolled through their physician. Since these patients predominantly enrolled through the national patient association, it seems plausible that more severely ill patients have been more likely to join this association, and thus these patients were probably not representative for the impact of LB in the general population. This further supports our decision to exclude these patients from the baseline and other scenarios.

When using the incidence estimates that include less likely LB diagnoses (scenario 2), the disease burden increased with 23%, illustrating that under-ascertainment may have led to substantial underestimation of the disease burden. Among the patients enrolled through their physician, the 5% most severely ill had a relatively high impact (28%) on the disease burden (scenario 3). Although this may be representative for LB in the general population, it also illustrates to what extent our estimates could be influenced by selection bias; i.e. if more severely ill cases have been more likely to be enrolled for the study through their physicians.

The influence of co-morbidity on our total disease burden estimate was at most modest (8%), and the observed difference may be due to other co-variables (scenario 4). Sporadic mortality due to LB would moderately increase the disease burden (14% with five annual deaths, scenario 5). We were not able to adjust for censoring in the patient group with persisting symptoms, but our censored estimate for the disease duration was similar to earlier reported durations of Lyme-related persisting symptoms.9,18 Nevertheless using the censored estimate may have substantially influenced our estimates, as raising our censored estimates with 25% proportionately increases the total disease burden with 22% (scenario 6). On the other hand, we also showed that if we combined this and all other scenarios based on physician enrolled patients, the disease burden converges towards the baseline (scenario 7): 15% above the baseline.

Figure 2 Sensitivity analysis: DALYs per LB outcome for baseline and seven scenarios. We performed a sensitivity analysis with seven alternative scenarios, exploring the consequences of using different estimates for the incidence, severity and duration of disease, or for possible mortality due to LB (table 1). On the y-axis, the baseline estimate and the seven alternative scenarios are indicated. The upper x-axis presents the DALYs per outcome for the entire population of the Netherlands (16.6 million), the lower x-axis DALYs per 100 000 population.
For reasons described in 25,26, in the BCoDE project a pathogen-based incidence approach was developed to derive DALYs for infectious diseases, rather than a prevalence based approach. We similarly derived DALYs using a pathogen-based incidence approach including long-term disease outcomes. However, instead of extrapolating the impact of long-term disease outcomes from the incidence of initial infections, we used the available incidence estimates for long-term disease outcomes in 2010.11 Although incident cases of long-term disease outcomes in 2010 originate from initial infections in 2009, this was no problem since the incidence of initial infections was the same for 2009 and 2010 (both ~22000 EM cases for 16.5 million pop.); the 2010 incidence for long-term outcomes is thus expected to be proportionate to the incidence of initial infections in 2010.

Age, sex and other covariates were not taken into account; studies with higher number of patients would facilitate further analysis of the influence and possible bias of such covariates. Furthermore, since unused questionnaires distributed through physicians were mostly not returned, we do not have insight into the non-response to validate to what extent our study population was representative. As an alternative validation, we compared the age and sex distributions of our study population and people acquiring tick bites.29 The two age distributions both show peaks around 10–14 years of age and around 50 years of age, although elderly people seem to be overrepresented in our study population; as a result the mean age of our study population was 52 years of age, whereas the mean age of people acquiring tick bites was 39 years. The sex distribution of our patients enrolled through physicians was similar to people acquiring tick bites—50% vs. 58% male respectively.

Conclusion

Lyme borreliosis has a substantial disease burden of 10.55 DALYs per 100 000 population (95% CI: 8.80–12.43) based on the incidence of LB in 2010 in the Netherlands (16.6 million pop.). This is the first estimate in DALYs of the public-health impact of LB, which will facilitate LB burden estimates for other countries. The disease burden is predominantly due to patients with persisting symptoms attributed to LB (9.09 DALYs per 100 000 pop.), and to a lesser extent due to patients with EM (0.60 DALYs) and disseminated LB (0.86 DALYs). Further research should focus on evaluating the effectiveness of prevention and control measures to reduce the disease burden, and especially on the mechanisms of developing persisting symptoms that patients and their physicians attribute to LB.

Acknowledgements

We thank Mirjam Kretzschmar, Scott McDonald, Alies van Lier and Roel Coutinho for reading and commenting on drafts of the manuscript.

Funding

This study was funded by the Dutch Ministry of Health, Welfare and Sport.

Conflicts of interest: None declared.

Key points

• We estimated the disease burden of Lyme borreliosis in the Netherlands expressed in Disability-Adjusted Life Years (DALYs), using available incidence estimates and a patient questionnaire to assess severity and duration of disease.

• This is the first DALY estimate of the public-health impact of Lyme borreliosis, which makes our results relevant for public-health prioritization in all countries where the disease is endemic.

• We found that the disease burden is substantial compared with a comprehensive list of 32 other infectious diseases, which is predominantly due to Lyme-related persisting symptoms.

• The observed disease burden due to Lyme-related persisting symptoms calls for further research to the mechanisms that cause these symptoms—whether or not due to past or present Borrelia infection—to be able to develop better prevention and treatment strategies for this patient group.

References


