AN EPIDEMIOLOGICAL REPORT ON LYME DISEASE

Authors:
Rhea Amonkar, Alisa Pallitto, Gabriela Salmeron

Faculty Sponsor:
Carolina Borges
Department of Public Health

ABSTRACT

Lyme disease is an inflammatory disease common across the globe that is caused by the bacteria *Borrelia burgdorferi* and is transmitted through the bite of infected deer ticks. It is found more commonly in certain geographic regions, especially those that are heavily wooded and at warmer times of the year. The disease is present in a lot of countries all over the world but can be more prevalent in areas where prevention policies are not in place, individuals are not aware of how to repel ticks, and "tick-safe zones" have not been established. Lyme disease is extremely prevalent in the United States but also many other European countries. In both the United States and other countries around the world, rates of Lyme disease are expected to increase in future years and will require further investigation into the subsequent trends.

INTRODUCTION

Lyme Disease is one of the most common vector-borne diseases in the United States. Vector-borne diseases result from the transmission of an infection from blood-feeding arthropods, including mosquitoes, ticks and fleas, to humans and animals. In Lyme disease, the infection is transmitted through the bite of infected Black-legged ticks. The main bacterial strain involved is *Borrelia burgdorferi* while a rarer strain is *Borrelia mayonii* (Centers for Disease Control and Prevention, 2021). This infection can be treated with antibiotics if diagnosed during an early stage (within 3-30 days after bite). However, if left untreated, the disease can spread to the joints, heart and nervous system; it can also induce Lyme Carditis, or heart palpitations and an irregular heartbeat. Over the last 30 years, the incidence of Lyme disease in the United States has nearly doubled, mostly due to factors related to climate change. One of the main reasons for the increasing incidence of Lyme disease is due to the lack of necessary funding, presence of outstanding questions raised into the diagnosis, and lack of seriousness in addressing the disease. There is still research needed to be done to identify an effective antibiotic in order to eradicate the microbe and cure the infection and disease.

GLOBAL INCIDENCE AND PREVALENCE RATES OF LYME DISEASE

In recent years, the worldwide pervasiveness of Lyme disease has increased and extended into countries where the disease had not previously been reported (Stone, 2017). Even though it is prevalent in a lot of countries around the world, aside from the United States, Lyme disease is seen throughout European countries more commonly. Though common in Europe, some countries are more heavily affected than others. Bavaria, Germany for example has prevalence reporting of 271 per 100,000 people from 2013 to 2020 and an incidence rate in 2020 of 47.5 per 100,000 people (Table 4). Less common in the United Kingdom but still prevalent, the prevalence ratings from 2005 to 2016 showed Lyme disease in 19.7 per 100,000 people and an incidence rate in 2016 of 2 per 100,000 people (Table 5). The environment plays a large role in the presence of ticks and the corresponding infection of Lyme disease, which explains a large reason behind the differences in countries, as will be analyzed later in the report.

More similar to the United States are the statistics of Lyme disease reporting in Canada. Recent studies are showing that Lyme disease is an emerging risk for Canadians in the southeastern and south-central areas, mostly due to the increasing geographic range of a specific Lyme disease causing tick species named *Ixodes scapularis* (Bouchard, 2015). The prevalence of

Lyme disease from 2009 to 2019 was 26.7 per 100,000 people and the incidence reporting from 2019 were 6.9 per 100,000 people (Table 3). Again, as will be discussed later, the geographic area as well as the time of year in which Lyme disease reporting are being studied has a large impact on the resulting numbers.

NATIONAL INCIDENCE AND PREVALENCE RATES OF LYME DISEASE

Driven by multiple factors, the numbers and distribution of reported cases of Lyme disease have increased over time (Environmental Protection Agency, 2021). As a percentage, the prevalence of Lyme disease in the United States from 2010 to 2019 was 0.07% or 76 per 100,000 people in that same time period (Table 1). The incidence rate of Lyme disease in the United states was 0.007% and 7.14 per 100,000 people in 2019 (Table 2).

NEW JERSEY STATE INCIDENCE AND PREVALENCE RATES OF LYME DISEASE

Lyme disease is the most commonly reported vector-borne illness in the United States and is most heavily reported in the Northeast and Upper Midwest, including states such as New Hampshire, Minnesota, Pennsylvania, and New Jersey (Health, D. of., 2021). The prevalence rate of Lyme disease in NJ from 2010 to 2019 is 0.35% or 348 per 100,000 people (Table 1), much larger than a lot of other states in the US. The incidence rate of Lyme disease in NJ from 2019 is 0.027% or 27 per 100,000 people (Table 2). The incidence rate of New Jersey remains above the incidence rate of the United States as a whole.

MORTALITY RATES

Because little data is available on the mortality rates of Lyme disease, statistics were only found to look at and analyze the overall mortality rate of the United States. Although not as recent as other data, the overall mortality rate in the United States from 2002 to 2007 was 1.097 per 100,000 people (Table 6). Data pertaining to the mortality rate of New Jersey could not be found. Specific data for both male mortality due to Lyme disease and female mortality due to Lyme disease could not be found for the United States or New Jersey. Additionally, data to find proportional mortality according to age groups in the United States or New Jersey could not be found.

Table 1: *Prevalence of Lyme Disease in USA & NJ, 2010-2019*

	USA	NJ
as a %	0.07%	0.35%
per 100,000 people	76	348

Table 2: *Incidence of Lyme Disease in USA & NJ, 2019*

	USA	NJ
as a %	0.007%	0.027%
per 100,000 people	7.14	27

Table 3: *Prevalence and Incidence of Lyme Disease in Canada, 2009-2019*

	Prevalence (2009-2019)	Incidence (2019)
as a %	0.027%	0.007%
per 100,000 people	26.7	6.9

Table 4: *Prevalence and Incidence of Lyme Disease in Bavaria, Germany, 2013-2020*

	Prevalence (2013-2020)	Incidence (2020)
as a %	0.27%	0.048%
per 100,000 people	271	47.5

Table 5: *Prevalence and Incidence of Lyme Disease in the United Kingdom, 2005-2016*

	Prevalence (2005-2016)	Incidence (2016)
as a %	0.019%	0.002%
per 100,000 people	19.7	2

Table 6: *Mortality Rates of USA and NJ, 2002-2007*

	USA	NJ
Overall Mortality	1.097 per 100,000	N/A
Male Mortality	N/A	N/A
Female Mortality	N/A	N/A
Age <65 Mortality	N/A	N/A
Age 65+ Mortality	N/A	N/A

EPIDEMIOLOGICAL TRENDING

Although the prevalence, incidence and overall mortality rates can vary depending on the condition and population level, there are strong epidemiological trends for Lyme disease that are derived from multiple factors. Lyme disease is driven by several factors and the distribution of reported cases over the years have increased over time. On a national level, the incidence of Lyme disease has approximately doubled since 1991 from 3.74 reported cases per 100,000 Americans to 7.95 reported cases per 100,000 Americans in 2014 (Environmental Protection Agency, 2016). Among the states in which the infection is most common, New Hampshire, Maine and Vermont

have undergone the largest increase in reported cases since 1991, followed by Delaware and Massachusetts.

When discussing the factors that determine these trends, climate change is seen to be one of the most influential factors of transmission, distribution and incidence of Lyme Disease. Climate change has contributed to the expanded number of ticks, therefore, increasing the potential risk of Lyme Disease on a global scale (Environmental Protection Agency, 2016). This is reflected in Canada where climate change has become abundant in their range of tick populations where the ticks were previously unable to survive due to cold temperatures. This shows how the life cycle and prevalence of deer ticks is strongly dependent on temperature because the warming temperatures of climate change cause an increase in the number of ticks. Tick-borne disease patterns are usually less influenced by short term changes in weather, such as in a range of weeks to months, than by long-term climate change. Human exposure to infected ticks is also influenced by several factors. With an increased awareness of Lyme disease, modified behaviors and the change in proximity of human populations to ticks and other hosts may help to control and eradicate the disease. Taking risk preventative measures such as spending less time outdoors, checking more carefully for ticks and using insect repellent can help reduce transmission.

When approaching the disease with solutions, the research community has lacked the necessary funding to advance the clinical and scientific understanding of the disease. This funding has also prevented the development of approaches for prevention, diagnosis and treatment. This may be an explanation for why there is not much data for Lyme disease, especially over the last few years. Many epidemiological measures, such as mortality rates for local regions, are not present on databases (Frontiers in Medicine, 2021). Researchers have also required better detection methods based on the different strains of bacteria that exist internationally. For example, there are some individuals who have an acute infection and do not show a humoral response. This may be due to the strain that was transmitted so it is crucial to assess the fatalities of each strain involved in Lyme. As Lyme disease continues to be on a rise, much of the infection can be attributed to conditions that allow the ticks to thrive in their hosts, like climate change. There was an initial solution known as LYMErix. Despite being the first preventative human vaccine for Lyme, it was relatively expensive and also induced autoimmune reactions in humans by attacking healthy tissue along with the harmful bacteria (The Guardian, 2019). Despite this downside, it provided hope because it appeared to be the first step towards eradicating the disease. Another larger issue is that a considerable portion of the medical community does not see Lyme as a problem. Many of the conventional antibiotics in place are not powerful enough to kill all of the *Borrelia* bacteria and remaining microbes in the body. When the remaining microbes survive, they repopulate and spread to other tissues. This may also give rise to antibiotic resistance, making it even more difficult to treat and cure. There is clinical evidence showing that intervention helps with the infection so there is a possibility of persuading people to take the condition seriously by developing new treatment protocols. It is also important to understand the other contributions of Lyme disease, including climate change and the interplay among the pathogen and vector (Stone et. al, 2017). The survival and development of ticks are influenced by temperature and humidity and studies predict that rising temperatures will raise the number of cases of Lyme Disease by more than 20 percent by mid-century (Forbes, 2021). Much of the present data suggests that Lyme disease cases will continue to increase if not taken seriously.

DESCRIPTIVE EPIDEMIOLOGICAL PERSPECTIVE

When understanding the spread of a disease or infection in a population, one must understand the distribution of health and of person variables. These include who is affected, where the condition occurs and when and over what time period the condition has occurred. It is important to note the epidemiology of Lyme disease related to the people, places and times affected to analyze other factors. Lyme disease affects people of any age, but the people who are most affected are those who spend time outdoors and engage in activities such as hiking and camping (Department of Health New York, 2017). Those who spend time in wooded environments are at increased risk of

exposure as that is the environment in which the bacterial strains of black-legged ticks thrive. People who work outdoors, like farmers and landscapers, are especially at risk (Environmental Protection Agency, 2016). The two bacterial strains, *B. burgdorferi* and *B. mayonii*, cause Lyme Disease in the United States while two other strains, *Borrelia afzelii* and *Borrelia garinii*, are the leading causes of the infection in Europe and Asia (Healio News, 2020). In the United States, most deer ticks are found in heavily wooded regions of the Northeast and Midwest. Most of the states who have reported ninety-three percent of cases from 1992-2006 include Connecticut, Delaware, Maryland, Massachusetts, Minnesota, New Jersey, New York, Pennsylvania, Rhode Island, and Wisconsin. In fact, Lyme disease is the most prevalent tick-borne infection in New York since 1986 (Department of Health New York, 2017). Due to these states being disproportionately affected by Lyme disease with incidence rates higher than other regions of the US, the CDC has not considered the Northwest states to be endemic for the disease. The chances of getting bitten by a deer tick is greater during the times of the year when the ticks are most abundant and active. The optimal conditions are when the temperature is about 45 degrees Fahrenheit or when the humidity is at least 85 percent. Warmer temperatures of climate change have been causing an increase in the number of ticks (Department of Health New York, 2017). Adult ticks are the most active from March to mid-May and from mid-August to November.

RISK FACTORS

The transmission of Lyme disease is caused by the bite of an infected black-legged tick, therefore certain interactions are risk factors. Spending time in outdoor wooded or grassy areas increases the risk of contracting the disease, due to the high level of exposure to ticks. Specifically, deer ticks in the United States are found heavily in wooded areas. Due to how easily ticks attach to bare flesh, having uncovered skin also develops potential risks. Bacteria from a tick bite can enter your bloodstream if the tick stays attached to your skin for 36 to 48 hours or longer (Mayo Clinic 2020). If the tick were to be removed within 2 days the chances of infection are minimized, therefore not removing a tick promptly raises the probability of infection.

PREVENTION AND CONTROL

The main source of prevention for Lyme disease is to avoid interactions with infected ticks or animals who may have ticks. Obtaining knowledge about where to expect ticks provides caution in exposed areas for individuals and pets. It is possible to prevent family pets from bringing ticks into the home by limiting their access to tick-infested areas (Centers for Disease Control and Prevention 2021). Performing frequent tick checks in spots like under the arms, in and around the ears, inside belly button, back of knees, in and around all head and body hair, and between the legs around the waist are recommended when coming inside from being outdoors in areas where ticks may be present. Repelling ticks on skin and clothes, as well as the prompt and proper removal of ticks counter the chances of infection. In addition, creating "tick safe zones" with the use of chemical control agents in commonly visited areas serves as prevention. Rashes and or fever may be early symptoms indicating infection, therefore remaining attentive to those factors can provide control.

CONCLUSION

Lyme disease affects people of all ages and genders but most specifically those who spend more time in wooded outdoor areas. It is prevalent throughout the globe but mainly in the United States and various European countries. It is expected that incidence and prevalence rates will increase for Lyme disease in the upcoming years. Climate change is one of the most influential factors of infection and distribution of the disease. Warmer temperatures that result from climate change cause an increase in the number of ticks. Risks of transmission of Lyme disease are most present in outdoor areas that are not "tick-safe" as well as in people with unprotected skin.

        The main source of prevention for Lyme disease is to remain cautious and avoid interactions with infected ticks. Remaining aware of potential exposure in outdoor areas, applying

repellent, and performing frequent tick checks decrease the possibility of transmission. In addition, the prompt and proper removal of a tick as well as being attentive to early symptoms such as fever or rash, could inhibit the disease from worsening.

There is a lack of information regarding prevention and treatment for Lyme disease due to the lack of funding for the research community. There have been few advancements in the clinical and scientific understanding of Lyme disease preventing methods of diagnosis and analysis. The absence of data has made it difficult to decrease risk of infection as well as finding definite prevention. With further research and advancements in treatments control measures can be implemented.

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