



QUALITY IN SPORT

eISSN 2450-3118 · Open Access · Peer-reviewed

apcz.umk.pl/QS Nicolaus Copernicus University in Toruń



Cite as: CZECH, Mateusz, TARCZYŃSKI, Dominik, MAZUR, Anna, CZMOK, Jakub, RADECKI, Jakub, CIESIELSKA, Dominika, KOCIUBA, Katarzyna, CHOJĘTA, Michał, BRZUSEK, Mikołaj, ZIEBA, Natalia, and CISLAK, Miłosz. Lyme Disease and Physical Activity: The Impact of the Disease on the Ability to Participate in Sports and the Importance of Prevention in Public Health. *Quality in Sport*. 2026;64:73398. <https://doi.org/10.12775/QS.2026.64.73398>

ARTICLE TIMELINE

Received: 15.06.2026. Revised: 01.07.2026. Accepted: 05.07.2026. Published: 16.07.2026.

The journal has been awarded 20 points in the parametric evaluation by the Polish Ministry of Higher Education and Science (Annex to the announcement of 05.01.2024, No. 32553). Unique Journal Identifier: 201398. Scientific disciplines assigned: Economics and finance (Field of social sciences); Management and Quality Sciences (Field of social sciences).

Punkty Ministerialne z 2019 – aktualny rok 20 punktów. Załącznik do komunikatu Ministra Szkolnictwa Wyższego i Nauki z dnia 05.01.2024 Lp. 32553. Posiada Unikatowy Identyfikator Czasopisma: 201398. Przypisane dyscypliny naukowe: Ekonomia i finanse (Dziedzina nauk społecznych); Nauki o zarządzaniu i jakości (Dziedzina nauk społecznych). © The Authors 2026.

OPEN ACCESS · CC BY-NC-SA 4.0 This article is published with open access under the License Open Journal Systems of Nicolaus Copernicus University in Toruń, Poland, and is distributed under the terms of the Creative Commons Attribution Non-commercial Share Alike License (<http://creativecommons.org/licenses/by-nc-sa/4.0/>), which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the work is properly cited. The authors declare no conflict of interest regarding the publication of this paper.

Lyme Disease and Physical Activity: The Impact of the Disease on the Ability to Participate in Sports and the Importance of Prevention in Public Health

Mateusz Czech

ORCID: <https://orcid.org/0009-0008-6980-6930>

mateuszczech102@gmail.com

Medical University of Lublin

Al. Raławickie 1; 20-059 Lublin; Poland

Dominik Tarczyński

ORCID: <https://orcid.org/0009-0004-5307-0130>

dominik.tarczynski02@gmail.com

Medical University of Lublin

Al. Raławickie 1; 20-059 Lublin; Poland

Anna Mazur

ORCID: <https://orcid.org/0009-0001-2568-0781>

mazurania2801@gmail.com

Medical University of Lublin

Al. Raławickie 1; 20-059 Lublin; Poland

Jakub Czmok

ORCID: <https://orcid.org/0009-0006-0869-9305>

Kubel2003@gmail.com

Medical University of Lublin

Al. Raławickie 1; 20-059 Lublin, Poland

Jakub Radecki

ORCID <https://orcid.org/0009-0005-5949-6965>

radecki7@icloud.com

Medical Univeristy of Lublin

Al. Raławickie1; 20-059 Lublin; Poland

Dominika Ciesielska

ORCID: <https://orcid.org/0009-0007-8548-1112>

dciesielska600@gmail.com

Medical University of Lublin

Aleje Raławickie 1; 20-059 Lublin; Poland

Katarzyna Kociuba

ORCID: <https://orcid.org/0009-0003-1265-2452>

katarzyna.kociuba1115@gmail.com

Medical University of Lublin

Al. Raławickie 1; 20-059 Lublin; Poland

Michał Chojęta

ORCID <https://orcid.org/0009-0007-0911-971X>

michalchojeta9@gmail.com

Medical University of Lublin

Al. Raławickie 1; 20-059 Lublin; Poland

Mikołaj Brzusek

ORCID: <https://orcid.org/0009-0005-6266-6988>

mrrib3002@gmail.com

Medical University of Lublin

Al. Raławickie 1; 20-059 Lublin; Poland

Natalia Zięba

ORCID: <https://orcid.org/0009-0005-4554-9536>

natalia.zieba03@gmail.com

Medical University of Lublin

Al. Raławickie 1; 20-059 Lublin; Poland

Miłosz Cislak

ORCID <https://orcid.org/0009-0006-3999-6185>

milosz.cislak@gmail.com

Medical University of Lublin

Al. Raławickie 1; 20-059 Lublin; Poland

Corresponding Author: Mateusz Czech mateuszczech102@gmail.com

Abstract

Background: Lyme disease is an infectious disease caused by various species of *Borrelia burgdorferi* bacteria transmitted by ticks. Increasing evidence suggests that it may affect an individual's ability to participate in sports and physical activity.

Aim of the study: The aim of this study was to summarize the current knowledge regarding the impact of Lyme disease on human body functioning, with particular emphasis on the

resulting changes and their consequences for the ability to undertake and engage in physical activity and sports.

Material and methods: A narrative literature review was conducted using publications available in the PubMed, Scopus, and Google Scholar databases. Cohort studies, meta-analyses, epidemiological studies, experimental studies, and systematic reviews concerning Lyme disease risk factors, preventive strategies, and its impact on physical activity were included.

Results: The analysis demonstrated that preventive measures, including post-exposure antibiotic prophylaxis, play a key role in reducing the number of new Lyme disease cases. Such interventions decrease the risk of infection and help limit long-term health consequences.

Conclusions: Lyme disease produces neurological, musculoskeletal, and systemic manifestations, including chronic fatigue and pain, which lead to reduced physical performance and diminished exercise tolerance.

Keywords: Lyme disease, Lyme disease prevention, tick-borne disease, outdoor sports, Lyme disease and sport, Lyme disease risk factors, Lyme disease pathophysiology

1. Introduction

Lyme borreliosis (LB) is a disease caused by various bacterial species belonging to the *Borrelia burgdorferi* sensu lato complex and transmitted by ticks. The disease is multisystemic in nature and progresses through distinct stages. It is the most common tick-borne disease in the United States, and its incidence has been steadily increasing for more than two decades. Human infection occurs during the feeding of an infected tick, when the bacteria migrate from the tick's midgut to its salivary glands and are subsequently transmitted to the host.

In the early stage of Lyme disease, the characteristic erythema migrans rash occurs in fewer than 60% of patients, typically appearing 7–10 days after a tick bite. This lesion may present as a uniformly red rash or a gradually expanding erythematous patch at the site of tick attachment. Other symptoms include fever, fatigue, muscle and joint pain, headaches, and lymphadenopathy. Once the bacteria enter the bloodstream, they may disseminate throughout

the body, leading to the involvement of multiple organs, particularly the heart, joints, and nervous system.

Neurological manifestations include facial nerve palsy, other cranial neuropathies, headaches, neck stiffness, chronic fatigue, sensory disturbances (paresthesia), signs of meningeal irritation, as well as mood disorders such as depression and anxiety. In some patients, additional complications may occur, including peripheral nervous system damage, encephalomyelitis, chronic meningitis, and stroke resulting from cerebral vasculitis [1].

Despite the steadily growing number of studies on Lyme disease, the mechanisms underlying its impact on physical performance and the ability to engage in physical activity have not yet been fully elucidated. Their clinical significance remains the subject of intensive scientific investigation. Lyme disease may lead to a variety of symptoms, including musculoskeletal pain, which can limit the ability to participate in sports and negatively affect patients' quality of life. Understanding the relationship between the course of the disease and physical activity is essential for developing effective recommendations regarding a safe return to exercise and appropriate therapeutic management.

At the same time, the prevention of Lyme disease plays a crucial role and includes both educational interventions and measures aimed at preventing tick bites. Effective prevention represents an important component of public health and may contribute to reducing the incidence of Lyme disease as well as mitigating its health-related consequences [2,3,4,5].

It has also been demonstrated that an increased risk of developing disseminated Lyme disease may be associated with low socioeconomic status and limited access to healthcare services [6]. The aim of this study is to present the current state of knowledge regarding the impact of Lyme disease on the ability to engage in physical activity and participate in sports, as well as to discuss the importance of preventive measures in protecting public health.

2. Materials and Methods

2.1 Literature Search and Study Selection

This study was conducted as a narrative review aimed at summarizing the current knowledge regarding the impact of Lyme disease on the ability to participate in sports, as well as the importance of preventive measures in public health. The literature review was based on publications available in the PubMed and Google Scholar databases, primarily covering the period from 2015 to 2026. Additional sources were obtained from reputable scientific

publishers and medical databases, including Springer. The literature search was performed using the following keywords: *Lyme disease*, *Lyme disease prevention*, *tick-borne disease sport outdoor*, *Lyme disease sport*, *Lyme disease risk factors*, and *Lyme disease and pathophysiology*. Studies included in the analysis comprised epidemiological studies, meta-analyses, systematic reviews, and selected experimental studies. The selection of publications was selective and focused on articles relevant to the subject matter of this review, with particular emphasis on the most recent scientific findings. Due to the narrative and cross-sectional nature of the study, no formal assessment of study quality or statistical analysis was performed.

2.2 AI

AI was utilized for two specific purposes in this research. Text analysis of clinical reasoning narratives to identify linguistic patterns associated with specific logical fallacies. Assistance in refining the academic English language of the manuscript, ensuring clarity, consistency, and adherence to scientific writing standards. AI were used for additional linguistic refinement of the research manuscript, ensuring proper English grammar, style, and clarity in the presentation of results. It is important to emphasize that all AI tools were used strictly as assistive instruments under human supervision. The final interpretation of results, classification of errors, and conclusions were determined by human experts in clinical medicine and formal logic. The AI tools served primarily to enhance efficiency in data processing, pattern recognition, and linguistic refinement, rather than replacing human judgment in the analytical process.

3. Research Results

3.1 Epidemiology of Lyme Disease

Lyme disease exhibits marked geographical variation across Europe. The highest incidence rates, exceeding 100 cases per 100,000 inhabitants annually, are observed in countries such as Estonia, Lithuania, Slovenia, and Switzerland. Poland belongs to the group of regions with a moderately high incidence, ranging from 40 to 80 cases per 100,000 inhabitants. In many countries of Western and Southern Europe, these rates are considerably lower and generally do not exceed 20 cases per 100,000 inhabitants. Epidemiological data also indicate substantial variation within individual countries, where highly endemic areas may occur locally. It is estimated that approximately 128,888 cases of Lyme disease are reported annually in Europe,

and nearly 24% of the continent's population lives in regions with high incidence rates. These findings highlight the importance of Lyme disease as a significant public health concern [7].

In the United States, the actual number of Lyme disease cases is likely substantially higher than that reported by official epidemiological surveillance systems. An analysis based on data from commercial health insurance claims demonstrated that, between 2010 and 2018, an average of approximately 476,000 individuals per year were diagnosed and treated for Lyme disease. Approximately 81% of cases were reported in the 14 states with the highest endemicity, located primarily in the northeastern part of the country and in the Upper Midwest region. These findings indicate a considerable underestimation of Lyme disease incidence in official reporting systems and confirm that the disease represents a major public health challenge characterized by pronounced geographical variation [8].

The most important species responsible for Lyme disease in North America is *Borrelia burgdorferi* sensu stricto. This bacterium is found primarily in the northeastern and Mid-Atlantic states of the United States, the Upper Midwest region, and northern California, while it is less commonly encountered in the states of Oregon and Washington and in adjacent regions of Canada. A much less common etiological agent of Lyme disease in North America is *Borrelia mayonii*, whose distribution is largely restricted to the northern part of the U.S. Midwest.

In Europe, the majority of infections are caused by *Borrelia garinii* and *Borrelia afzelii*, whereas *Borrelia burgdorferi* sensu stricto and *Borrelia bavariensis*, a species closely related to *B. garinii*, are of lesser epidemiological importance. In Asia, *B. garinii* is the predominant species, although *B. bavariensis* and *B. afzelii* are also present [9].

Studies investigating risk factors for disseminated Lyme disease have shown that individuals who remained under medical observation for at least half of the analyzed period had approximately a 20% higher risk of developing the disseminated form of the disease compared with patients who did not regularly utilize healthcare services. At the same time, contact with a primary care physician was associated with a 41% reduction in this risk. An even greater protective effect was observed when the diagnosis was established in an emergency department, where the risk of developing disseminated Lyme disease was 78% lower than among patients managed exclusively in outpatient settings [6].

3.2 Impact of Lyme Disease on the Human Body

Due to its multisystem nature, infection caused by *Borrelia* spirochetes can lead to pathological changes involving multiple organ systems. The course of the disease may include dermatological, articular, muscular, neurological, cardiac, and ophthalmological manifestations.

Cutaneous manifestations are among the earliest signs of Lyme disease and may present in both typical and atypical forms. The classic manifestation of Lyme disease is erythema migrans, which appears as a circular macular rash, sometimes with central clearing, creating a characteristic “bull’s-eye” appearance. This lesion gradually enlarges over time. Less common dermatological manifestations include acrodermatitis chronica atrophicans and borrelial lymphocytoma, which typically presents as a solitary, painless, bluish-red nodule or plaque, most frequently located on the earlobe [10].

Lyme arthritis is the most common late manifestation of *Borrelia burgdorferi* infection in the United States and typically develops several months after the bite of an infected tick. Currently, joint involvement constitutes the predominant clinical manifestation of the disease in many patients. Lyme arthritis most commonly presents with pain and swelling of one or several large joints, with the knee joint being particularly frequently affected by the inflammatory process [11]. During the course of infection, remodeling of the synovial membrane occurs, primarily involving fibrosis and an intensification of the inflammatory response. Macrophages, T lymphocytes, natural killer (NK) cells, and plasma cells participate in the initiation and maintenance of this inflammatory process. NK cells and T lymphocytes produce interferon gamma (IFN- γ), which plays a significant role in amplifying the inflammatory response [9].

Lyme disease may also involve cardiac structures, leading to the development of Lyme carditis [12]. Cardiac manifestations may present with a highly heterogeneous clinical spectrum, ranging from asymptomatic abnormalities detectable only on electrocardiographic recordings, through varying degrees of atrioventricular conduction disturbances, to severe clinical forms that, in extreme cases, may lead to sudden cardiac death [13]. Early diagnosis and the prompt initiation of antibiotic therapy may result in the complete resolution of cardiac arrhythmias [14]. However, in some patients, permanent pacemaker implantation may be required. An example is the case of a man in his thirties who was admitted to the hospital due to syncopal episodes lasting for one day. Diagnostic evaluation revealed complete atrioventricular block and multiple symptomatic cardiac pauses, the longest of which lasted 30 seconds. Given his frequent

occupational exposure to ticks, diagnostic testing for Lyme disease was performed and confirmed the presence of both IgM and IgG antibodies against *Borrelia burgdorferi*. Following unsuccessful antibiotic therapy, the patient ultimately required pacemaker implantation [15].

Lyme disease may also involve the nervous system, leading to the development of neuroborreliosis. Untreated or persistent infection may result in neurological complications in predisposed individuals [16]. To assess the role of inflammatory processes in the development of neuroborreliosis, studies were conducted in rhesus macaques that received intrathecal inoculation with live *B. burgdorferi* spirochetes. Analysis of cerebrospinal fluid demonstrated a marked increase in the concentrations of inflammatory mediators, including IL-6, IL-8, CCL2, and CXCL13, as well as an increased number of inflammatory cells. Immunofluorescence studies confirmed the presence of *B. burgdorferi* antigens in the dorsal root ganglia and dorsal roots of the spinal nerves. Histopathological examination revealed numerous inflammatory lesions involving the meninges, blood vessels, and inflammatory foci within the central nervous system. Necrotizing myelitis, radiculitis, damage to and demyelination of spinal nerves, as well as neurodegenerative changes in the dorsal root ganglia were also observed, accompanied by increased apoptosis of neurons and glial cells. These findings indicate that inflammation plays a pivotal role in the development and progression of acute Lyme neuroborreliosis [17].

Lyme disease may also present with atypical ophthalmic manifestations, including orbital myositis and involvement of the cranial nerves. The disease should be considered in the differential diagnosis of inflammatory orbital disorders, particularly in patients from endemic regions. Early diagnosis and the initiation of appropriate antibiotic therapy usually result in rapid symptom resolution and a favorable prognosis. An illustrative case involved a 69-year-old man from northern New York State who presented with diplopia, eyelid and conjunctival edema, and numbness of the left side of the face. Clinical examination revealed proptosis, palsies of the cranial nerves responsible for ocular motility, and restricted eye movements. Laboratory investigations confirmed infection with *Borrelia burgdorferi*, while cerebrospinal fluid analysis demonstrated evidence of an inflammatory process. Notably, the patient reported no prior tick bite, fever, or characteristic rash. Magnetic resonance imaging revealed inflammatory changes involving the extraocular muscles and orbital tissues. After other potential causes of the symptoms had been excluded, treatment with intravenous ceftriaxone

was initiated, resulting in significant clinical improvement. Follow-up MRI performed two months later confirmed regression of the inflammatory lesions [18].

3.3 Impact of Lyme Disease on the Ability to Participate in Sports

Lyme disease and post-treatment Lyme disease syndrome (PTLDS) may significantly affect an individual's ability to engage in physical activity. The course of the disease and its clinical sequelae often lead to reduced physical performance and diminished exercise tolerance.

In some patients, symptoms of Lyme disease persist for an extended period despite appropriate treatment. A prospective cohort study demonstrated that the most commonly reported complaints were chronic fatigue, pain, and cognitive dysfunction. These symptoms persisted for at least six months following the completion of therapy.

These findings suggest that Lyme disease may lead to a long-term reduction in physical fitness and impairment of daily functioning. Chronic fatigue and pain significantly limit exercise tolerance, reduce physical performance, and hinder engagement in regular physical and sporting activities. Consequently, this may affect both the ability to train and the duration of post-exercise recovery, while also restricting overall participation in physical activity. The study further highlights the importance of early diagnosis and effective prevention of Lyme disease, as a proportion of patients continue to experience symptoms affecting their quality of life and physical functioning even after completing treatment [19].

The most important factors associated with the persistence of symptoms following Lyme disease include reduced physical capacity and social functioning, higher levels of depression and anxiety, a negative perception of one's illness, the presence of comorbid conditions, as well as pronounced fatigue, cognitive dysfunction, and chronic pain symptoms [20].

Survey-based studies have also indicated that patients with post-treatment Lyme disease syndrome (PTLDS) frequently experience autonomic dysfunction, including symptoms resembling those observed in postural orthostatic tachycardia syndrome (POTS). Dysfunction of the autonomic nervous system may lead to exercise intolerance, rapid fatigue, and reduced tolerance to physical activity, which is of particular importance in the context of returning to sports and recreational activities [21].

3.4 Pharmacology and Prevention of Lyme Disease

The prevention of Lyme disease includes measures aimed at reducing the risk of bites from infected ticks and preventing the development of infection following exposure. The primary

component of primary prevention is avoiding contact with ticks. The use of appropriate protective clothing is recommended when spending time in forested and grassy areas, including long trousers, closed footwear, and light-colored clothing, which facilitates the detection of ticks. The use of repellents containing tick-repellent substances, such as DEET, icaridin, or permethrin (applied to clothing), is also important. Following exposure in endemic areas, careful inspection of the skin and prompt tick removal are recommended, as the risk of bacterial transmission increases with the duration of tick attachment and feeding.

An important component of prevention is the proper and prompt removal of ticks using appropriate tools, without the application of irritating substances that may increase the risk of pathogen transmission. The shorter the duration of tick attachment and feeding, the lower the likelihood of infection with *Borrelia burgdorferi*.

Pharmacological management of Lyme disease includes both the treatment of infection and preventive measures following tick exposure. Antibiotic therapy remains the cornerstone of treatment, while increasing attention is also being directed toward the development of vaccines and post-exposure preventive strategies.

In studies evaluating the experimental VLA15 vaccine, based on the *Borrelia burgdorferi* outer surface protein A (OspA), the efficacy of a booster dose and the safety profile of the vaccine were assessed. A significant increase in IgG antibody titers against all six OspA serotypes was observed in the vaccinated group compared with the placebo group. The most frequently reported adverse events were local injection-site reactions, which occurred more often among vaccine recipients, whereas the incidence of systemic adverse events was comparable between the two groups. No serious adverse events were reported. These findings indicate that a booster dose of VLA15 induces a strong and broad immune response while maintaining a favorable safety profile. At the same time, the observed decline in antibody levels over time suggests that periodic booster doses, likely administered on an annual basis, may be required to ensure long-term protection [22].

An important component of the pharmacological prevention of Lyme disease is post-exposure antibiotic prophylaxis. Studies have demonstrated that the administration of a single 200 mg dose of doxycycline within 72 hours of a bite from an infected tick significantly reduces the risk of developing Lyme disease and erythema migrans, the earliest clinical manifestation of the infection. Studies have shown that patients receiving a single dose of doxycycline had a 71% lower risk of developing Lyme disease compared with those receiving placebo.

Furthermore, none of the patients in the experimental group developed erythema migrans after receiving doxycycline (100 mg twice daily) for 3–5 days, whereas in the control group, whose participants did not receive any antibiotic treatment, erythema migrans developed in 5 of 97 patients.

During follow-up, no conclusive evidence was found to support the effectiveness of either topical treatment or a 10-day course of antibiotic therapy. A meta-analysis demonstrated that the number needed to treat (NNT) is approximately 50, indicating that administering a single dose of doxycycline to 50 individuals following a tick bite prevents one case of Lyme disease. At the same time, the use of doxycycline is associated with certain adverse effects, including enterocolitis, anaphylaxis (including angioedema), Stevens–Johnson syndrome, severe urticarial reactions, and lupus-like syndrome [23].

5. Importance of Prevention in Public Health

At the public health level, the prevention of Lyme disease plays a crucial role in reducing the incidence of infection, particularly among groups at increased risk of tick exposure. Studies conducted among hunters and forestry workers have shown that, despite their elevated risk of contact with ticks, not all individuals employ appropriate preventive measures, and some continue to use ineffective methods of tick removal. Among hunters, tick removal with tweezers was the most commonly reported practice, whereas forestry workers more frequently reported covering the tick with an oily substance before removal. These findings highlight the need for targeted health education among occupational and recreational groups associated with forested environments [24].

Epidemiological data indicate that Lyme disease occurs most frequently in children aged 5–9 years, which is associated with age-specific behavioral patterns and frequent exposure to environments inhabited by ticks. Therefore, preventive measures should be specifically tailored to this age group [25].

An important factor influencing the adoption of protective behaviors is the perceived risk of the disease. Individuals who consider Lyme disease to be a common health concern are more likely to inspect their bodies after spending time in green spaces, use repellents, and engage in other risk-reduction practices, such as showering or bathing after outdoor exposure and using tick-control products on domestic animals. Furthermore, awareness of the local prevalence of Lyme disease is one of the most significant determinants of adherence to preventive

recommendations, highlighting the need to increase public knowledge regarding the actual risk of infection [26].

Among residents of endemic areas, individuals who perceived tick-borne diseases as common—either because members of their families had been affected or because they directly observed the presence of ticks in the vicinity of their homes—were more likely to perform tick checks and implement measures aimed at reducing tick abundance in their surroundings. Information disseminated by public health institutions was also associated with more frequent adoption of preventive behaviors among the populations it reached. The main barriers to the implementation of preventive measures included forgetfulness, concerns regarding safety, and insufficient knowledge [27].

Differences in preventive behaviors can also be observed between populations. This was demonstrated in a study conducted among students from Poland, Germany, and Thailand, in which the choice of tick-protection methods was influenced by sociodemographic factors and the level of health education. Most Polish and German students reported performing body inspections after returning home and wearing protective clothing, whereas Thai students most commonly reported wearing protective clothing and adopting preventive behaviors while in tick habitats. The fact that some future healthcare professionals did not engage in any preventive measures highlights the need to improve educational programs and to strengthen initiatives promoting the prevention of tick-borne diseases within the general population [28].

In light of the findings presented, effective Lyme disease prevention requires not only individual protective behaviors but also comprehensive public health measures, including education, health promotion, and targeted interventions directed at populations at increased risk of infection.

6. Summary and Conclusions

Lyme disease is a multisystem disorder that can significantly affect an individual's ability to engage in and sustain physical activity. The course of the infection and its clinical sequelae, including neurological, musculoskeletal, and systemic manifestations such as chronic fatigue and pain, may lead to reduced physical performance and diminished exercise tolerance. Consequently, some patients experience difficulties returning to their previous level of physical activity, including participation in sports.

Available evidence indicates that, even after the completion of treatment, some patients may continue to experience symptoms associated with post-treatment Lyme disease syndrome (PTLDS), including fatigue, cognitive dysfunction, and pain. These symptoms may significantly impair physical performance, prolong recovery time, and limit training capacity. Furthermore, autonomic dysfunction observed in some patients may result in exercise intolerance and increased fatigability, representing a substantial limitation in the context of sports participation.

Prevention plays a key role in reducing the incidence of new infections. It primarily involves non-specific measures, such as avoiding tick bites through the use of appropriate protective clothing, repellents, and thorough skin inspection following exposure to endemic areas. Prompt and proper tick removal is also essential, as it reduces the risk of pathogen transmission. In selected cases, post-exposure antibiotic prophylaxis may also be employed.

Research on vaccines against Lyme disease offers hope for more effective prevention of infection in the future; however, preventive measures and health education currently remain of paramount importance. Effective prevention is essential not only for reducing the risk of infection but also for limiting its long-term health consequences, including impaired physical performance and reduced quality of life among affected individuals.

In conclusion, Lyme disease may substantially limit the ability to engage in physical activity both during the acute phase of the illness and following recovery. Therefore, early diagnosis, effective treatment, and consistent preventive measures are of critical importance. Prevention remains the most important tool for reducing the impact of this disease on public health and on the physical activity levels of the population.

Disclosure

The authors report no disclosures.

Author's contribution Statement

Conceptualization: Mateusz Czech, Dominik Tarczyński

Methodology: Michał Chojęta, Miłosz Cisłak

Software: Not applicable

Check: Mateusz Czech

Formal analysis: Dominika Ciesielska, Natalia Zięba, Mikołaj Brzusek

Investigation: Katarzyna Kociuba, Anna Mazur

Resources: Mateusz Czech

Data curation: Jakub Czmok, Mikołaj Brzusek

Writing-rough preparation: Mateusz Czech, Katarzyna Kociuba, Mikołaj Brzuszek

Writing review and editing: Anna Mazur, Dominik Tarczyński, Miłosz Cisłak

Visualization: Jakub Czmok, Michał Chojęta

Supervision: Mateusz Czech

Project administration: Natalia Zięba, Dominika Ciesielska

Receiving funding: Not applicable.

All authors have read and agreed to the published version of the manuscript.

Funding Statement:

This research received no external funding.

Institutional Review Board Statement:

Not applicable.

Informed Consent Statement:

Not applicable.

Data Availability Statement:

Not applicable.

Acknowledgments:

Not applicable.

Conflict of Interest Statement:

The authors declare no conflict of interest.

References

1. Zubcevik, N., Mao, C., Wang, Q. M., Bose, E. L., Octavien, R. N., Crandell, D., & Wood, L. J. (2020). *Symptom clusters and functional impairment in individuals treated for Lyme borreliosis*. *Frontiers in Medicine*, 7, Article 464. <https://doi.org/10.3389/fmed.2020.00464>
2. Aucott, J. N., Yang, T., Yoon, I., Powell, D., Geller, S. A., & Rebman, A. W. (2022). *Risk of post-treatment Lyme disease in patients with ideally-treated early Lyme disease: A prospective cohort study*. *International Journal of Infectious Diseases*, 116, 230–237. <https://doi.org/10.1016/j.ijid.2022.01.033>
3. Foret, J., Paren, A.-J., Zayet, S., Chirouze, C., Gendrin, V., Bouiller, K., & Klopfenstein, T. (2025). *Residual symptoms and quality of life after treated Lyme neuroborreliosis: Case–control study (QoLYME)*. *Open Forum Infectious Diseases*, 12(2), ofaf042. <https://doi.org/10.1093/ofid/ofaf042>
4. Rebman, A. W., Bechtold, K. T., Yang, T., Mihm, E. A., Soloski, M. J., Novak, C. B., & Aucott, J. N. (2017). *The clinical, symptom, and quality-of-life characterization of a well-defined group of patients with posttreatment Lyme disease syndrome*. *Frontiers in Medicine*, 4, Article 224. <https://doi.org/10.3389/fmed.2017.00224>
5. Rebman, A. W., Yang, T., & Aucott, J. N. (2021). *Symptom heterogeneity and patient subgroup classification among US patients with post-treatment Lyme disease: An observational study*. *BMJ Open*, 11(1), e040399. <https://doi.org/10.1136/bmjopen-2020-040399>
6. Moon, K. A., Pollak, J. S., Poulsen, M. N., Heaney, C. D., Hirsch, A. G., & Schwartz, B. S. (2021). *Risk factors for Lyme disease stage and manifestation using electronic health records*. *BMC Infectious Diseases*, 21(1), 1269. <https://doi.org/10.1186/s12879-021-06959-y>
7. Burn, L., Tran, T. M. P., Pilz, A., Vyse, A., Fletcher, M. A., Angulo, F. J., Gessner, B. D., Moïsi, J. C., Jodar, L., & Stark, J. H. (2023). *Incidence of Lyme borreliosis in Europe from national surveillance systems (2005–2020)*. *Vector-Borne and Zoonotic Diseases*, 23(4), 156–171. <https://doi.org/10.1089/vbz.2022.0071>
8. Kugeler, K. J., Schwartz, A. M., Delorey, M. J., Mead, P. S., & Hinckley, A. F. (2021). *Estimating the frequency of Lyme disease diagnoses, United States, 2010–2018*. *Emerging Infectious Diseases*, 27(2), 616–619. <https://doi.org/10.3201/eid2702.202731>

9. Lochhead, R. B., Strle, K., Arvikar, S. L., Weis, J. J., & Steere, A. C. (2021). *Lyme arthritis: Linking infection, inflammation and autoimmunity*. *Nature Reviews Rheumatology*, 17(8), 449–461. <https://doi.org/10.1038/s41584-021-00648-5>
10. Myszkowska-Torz, A., Tomaszewski, M., Kotowski, M., Witczak, C., Figlerowicz, M., & Mazur-Melewska, K. (2023). *Cutaneous manifestations of Lyme borreliosis in children—A case series and review*. *Life*, 13(1), 72. <https://doi.org/10.3390/life13010072>
11. Arvikar, S. L., & Steere, A. C. (2022). *Lyme arthritis*. *Infectious Disease Clinics of North America*, 36(3), 563–577. <https://doi.org/10.1016/j.idc.2022.03.006>
12. Büscher, A., Doldi, F., Eckardt, L., & Müller, P. (2022). *Lyme carditis manifesting with sinoatrial exit block: A case report*. *European Heart Journal: Case Reports*, 6(1), ytac022. <https://doi.org/10.1093/ehjcr/ytac022>
13. Kannangara, D. W., Sidra, S., & Patel, P. (2019). *First case report of inducible heart block in Lyme disease and an update of Lyme carditis*. *BMC Infectious Diseases*, 19(1), 428. <https://doi.org/10.1186/s12879-019-4025-0>
14. Bourji, K. I., Newsome, T., & Meyerhoff, J. (2018). *Rapid complete atrioventricular heart block reversal due to Lyme carditis*. *Journal of Community Hospital Internal Medicine Perspectives*, 8(4), 241–243. <https://doi.org/10.1080/20009666.2018.1503918>
15. Baron, S., Nepal, S., Lamichhane, M., & Roseman, H. (2022). *Unresolved heart block in Lyme carditis: A case report*. *Cureus*, 14(9), e29661. <https://doi.org/10.7759/cureus.29661>
16. Parthasarathy, G., Pattison, M. B., & Midkiff, C. C. (2023). The FGF/FGFR system in the microglial neuroinflammation with *Borrelia burgdorferi*: Likely intersectionality with other neurological conditions. *Journal of Neuroinflammation*, 20(1), 10. <https://doi.org/10.1186/s12974-022-02681-x>
17. Ramesh, G., Didier, P. J., England, J. D., Santana-Gould, L., Doyle-Meyers, L. A., Martin, D. S., Jacobs, M. B., & Philipp, M. T. (2015). *Inflammation in the pathogenesis of Lyme neuroborreliosis*. *The American Journal of Pathology*, 185(5), 1344–1360. <https://doi.org/10.1016/j.ajpath.2015.01.024>
18. Biso, G. M., Mangla, R., & Eldokla, A. M. (2023). *Orbital myositis as an initial presentation of Lyme disease*. *Neurology*, 101(20), 914–915. <https://doi.org/10.1212/WNL.0000000000207742>

19. Ursinus, J., Vrijmoeth, H. D., Harms, M. G., Tulen, A. D., Knoop, H., Gauw, S. A., Zomer, T. P., Wong, A., Friesema, I. H. M., Vermeeren, Y. M., Joosten, L. A. B., Hovius, J. W., Kullberg, B. J., & van den Wijngaard, C. C. (2021). *Prevalence of persistent symptoms after treatment for Lyme borreliosis: A prospective observational cohort study. The Lancet Regional Health – Europe*, 6, 100142. <https://doi.org/10.1016/j.lanepe.2021.100142>
20. Vrijmoeth, H. D., Ursinus, J., Harms, M. G., Tulen, A. D., Baarsma, M. E., van de Schoor, F. R., Gauw, S. A., Zomer, T. P., Vermeeren, Y. M., Ferreira, J. A., Sprong, H., Kremer, K., Knoop, H., Joosten, L. A. B., Kullberg, B. J., Hovius, J. W., & van den Wijngaard, C. C. (2023). Determinants of persistent symptoms after treatment for Lyme borreliosis: A prospective observational cohort study. *eBioMedicine*, 98, 104825. <https://doi.org/10.1016/j.ebiom.2023.104825>
21. Adler, B. L., Rebman, A. W., Chung, T., Miller, J. B., Keshtkarjahromi, M., Yang, T., Savigamin, C., Azola, A., Rowe, P. C., & Aucott, J. N. (2025). *Autonomic symptoms in post-treatment Lyme disease: Insights from the COMPASS-31 and the 10-minute active stand test. Mayo Clinic Proceedings: Innovations, Quality & Outcomes*, 9(6), 100674. <https://doi.org/10.1016/j.mayocpiqo.2025.100674>
22. Ghadge, S. K., Schneider, M., Dubischar, K., Wagner, L., Kadlecsek, V., Obersriebnig, M., Hochreiter, R., Klingler, A., Larcher-Senn, J., Derhaschnig, U., Bender, W., Eder-Lingelbach, S., Bézay, N., et al. (2024). Lyme borreliosis vaccine candidate after primary immunisation in healthy adults in the USA: Results of the booster phase of a randomised, controlled, phase 2 trial. *The Lancet Infectious Diseases*, 24(11), 1275–1286. [https://doi.org/10.1016/S1473-3099\(24\)00372-4](https://doi.org/10.1016/S1473-3099(24)00372-4)
23. Zhou, G., Xu, X., Zhang, Y., Yue, P., Luo, S., Fan, Y., Chen, J., Liu, M., Dong, Y., Li, B., Kong, J., Wen, S., Liu, A., & Bao, F. (2021). Antibiotic prophylaxis for prevention against Lyme disease following tick bite: An updated systematic review and meta-analysis. *BMC Infectious Diseases*, 21(1), 1141. <https://doi.org/10.1186/s12879-021-06837-7>
24. Tokarska-Rodak, M., Shkilna, M., Krajewska, M., Pańczuk, A., Weiner, M., Pawłowicz, E., Korda, M., Klisch, I., & Andreychyn, M. (2020). *[The evaluation of hunters and foresters' knowledge of the possible ways of preventing Borrelia burgdorferi infections]*. *Medycyna Pracy*, 71(1), 59–68. <https://doi.org/10.13075/mp.5893.00841>

25. Kugeler, K. J., Mead, P. S., Schwartz, A. M., & Hinckley, A. F. (2022). *Changing trends in age and sex distributions of Lyme disease—United States, 1992–2016*. *Public Health Reports*, 137(4), 655–659. <https://doi.org/10.1177/00333549211026777>
26. Niesobecki, S., Hansen, A., Rutz, H., Mehta, S., Feldman, K., Meek, J., Niccolai, L., Hook, S., & Hinckley, A. (2019). *Knowledge, attitudes, and behaviors regarding tick-borne disease prevention in endemic areas*. *Ticks and Tick-Borne Diseases*, 10(6), 101264. <https://doi.org/10.1016/j.ttbdis.2019.07.008>
27. Beck, A., Bjork, J., Biggerstaff, B. J., Eisen, L., Eisen, R., Foster, E., Signs, K., Tsao, J. I., Kough, E., Peterson, M., Schiffman, E., Muganda, C. P., Osborn, R., Wozniak, R., Bron, G. M., Phaneuf, D., Smith, D., Bartholomay, L., Paskewitz, S., & Hinckley, A. F. (2022). *Knowledge, attitudes, and behaviors regarding tick-borne disease prevention in Lyme disease-endemic areas of the Upper Midwest, United States*. *Ticks and Tick-Borne Diseases*, 13(3), 101925. <https://doi.org/10.1016/j.ttbdis.2022.101925>
28. Buczek, A., Pilch, J., & Buczek, W. (2020). *Tick preventive behaviors and practices adopted by medical students from Poland, Germany, and Thailand in relation to socio-demographic conditions and their knowledge of ticks and tick-borne diseases*. *Insects*, 11(12), 863. <https://doi.org/10.3390/insects11120863>