

STRATEGIES FOR THE PRIMARY PREVENTION OF LYME DISEASE

STRATEGIE PROFILAKTYKI BORELIOZY

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A. Study design/planning
zaplanowanie badań
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zebranie danych
C. Data analysis/statistics
dane – analiza i statystyki
D. Data interpretation
interpretacja danych
E. Preparation of manuscript
przygotowanie artykułu
F. Literature analysis/search
wyszukiwanie i analiza literatury
G. Funds collection
zebranie funduszy

Summary

This study aimed to analyze the severity of risks associated specific tick-borne diseases and to identify directions for the development of preventive measures, particularly for Lyme disease. Thus, a detailed literature review was performed to analyze epidemiological data and the latest scientific research in the field of prevention and health education for Lyme disease. The World Health Organization (WHO) indicated that it is necessary to increase the level of knowledge and health awareness of individuals living in the highest-risk areas and who travel to countries with endemic vectors. Additional activities of the WHO in the area of vector-borne disease prevention resulted from the adoption of the global vector control response 2017-2030 (GVCR 2017-2030), which focused on diseases transmitted by vectors. At the EU level, activities include the European Emerging and Vector-borne Diseases (EVD) program. At the national level, the basic legal act related to the issue of infectious diseases is the Act of 5 December 2008 on preventing and combating infections and infectious diseases in humans. The main body implementing activities in the field of prevention and health education in Poland is the Chief Sanitary Inspectorate (GIS). Creating new ways to implement preventive actions, including those regarding the problem of tick-borne diseases in humans, should take into account a number of factors that determine their effectiveness. The creation of effective educational strategies translates into the effectiveness of prevention efforts and negative social effects.

Keywords: Lyme disease, primary prevention, health policy

Streszczenie

Celem pracy jest analiza skali zagrożenia związanego ze specyfiką chorób odkleszczowych, w tym szczególnie boreliozy oraz wyznaczenie kierunków działań profilaktycznych. W tym celu dokonano szczegółowego przeglądu literatury, analizując dane epidemiologiczne oraz najnowsze badania naukowe z obszaru profilaktyki i edukacji zdrowotnej, w aspekcie zjawiska boreliozy. Jak wskazała WHO w uzasadnieniu podjęcia tematu chorób wektorowych, istotnym działaniem jest zwiększenie poziomu wiedzy i świadomości zdrowotnej ludności mieszkającej na obszarach najbardziej zagrożonych, jak również podróżujących do krajów endemicznego występowania chorobotwórczych wektorów. Dodatkowa aktywność WHO w zakresie profilaktyki chorób powodowanych przez wektory wynika z przyjęcia globalnej strategii w zakresie chorób przenoszonych przez wektory na lata 2017-2030 (GVCR 2017-2030). Na poziomie krajowym podstawowym aktem prawnym odnoszącym się do problematyki chorób zakaźnych jest ustawa z dnia 5 grudnia 2008 r. o zapobieganiu oraz zwalczaniu zakażeń i chorób zakaźnych u ludzi. Podstawowym podmiotem realizującym działania z zakresu profilaktyki i edukacji zdrowotnej w Polsce jest Główny Inspektorat Sanitarny. Kreowanie nowych sposobów na realizację działań profilaktycznych, obejmujących problem chorób odkleszczowych u ludzi, powinno uwzględnić szereg czynników determinujących ich skuteczność. Budowanie efektywnych strategii edukacyjnych przekłada się bowiem na skuteczność zapobiegania negatywnym skutkom zdrowotnym i społecznym.

Słowa kluczowe: borelioza, profilaktyka, polityka zdrowotna

Tables: 0

Figures: 0

References: 37

Submitted: 2020 Apr 23

Accepted: 2020 Jul 27

Kaczoruk M, Pacian AB, Kawiak-Jawor E, Kaczor-Szkodny P. Strategies for the primary prevention of Lyme disease. Health Prob Civil. 2020; 14(4): 275-282. <https://doi.org/10.5114/hpc.2020.97778>

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Introduction

Lyme disease was first described in Lyme in the United States in 1975 [1,2]. Several cases that were similar to juvenile rheumatoid arthritis were reported in a large group of children. In adults, the disease also manifested as skin changes and disorders of the nervous and circulatory systems. Research that has been conducted since then led to the discovery of an etiological factor in 1982, which was named *Borrelia burgdorferi* (*B. burgdorferi*) [3] after its discoverer. In Poland, the incidence of Lyme disease was recognized in the 1980s [4]. Over the past few decades, there has been a significant increase in the incidence of tick-borne diseases in humans (specifically Lyme disease). The number of cases in Europe has steadily increased, and more than 360,000 cases were reported over the last two decades. Currently, Lyme disease occurs worldwide [5]. The reasons for the increasing incidence of Lyme disease include the constantly changing geographical range of ticks and the extension of the feeding period for ticks (which are a vector of the *B. burgdorferi* spirochete – a biological pathogen that causes Lyme disease in humans) [6]. Migrating birds that carry infected ticks to areas where spirochetes were not previously present play an important role in disease spread [5]. Lyme disease is the most common vector-borne disease in Europe and the United States. In Europe, over 85,000 new cases are reported each year [6]. The incidence of the disease can reach up to 300 per 100,000 individuals in endemic regions in Europe [7]. The development of effective preventive measures in this area has become a major public health challenge.

Aim of the study

This study aimed to analyze the severity of risks associated with specific tick-borne diseases, especially Lyme disease (the most common tick-borne disease in Europe, Asia and North America) and to identify directions for preventive measures. To achieve this aim, a detailed literature review was performed, and epidemiological data and the latest scientific research in the field of the prevention and health education for Lyme disease and other tick-borne diseases were analyzed.

Brief description of the status of knowledge

Lyme borreliosis is a multiorgan disease caused by the spirochete *B. burgdorferi sensu lato*. This spirochete is transmitted by hard ticks of the Ixodes genus, which feed on human and animal blood. The reservoirs of *Borrelia* spirochetes are rodents and small mammals. Human infection occurs after being bitten by an infected tick. Due to the small size of ticks and the presence of anesthetic substances in their saliva, bites may go unnoticed by humans during feeding [8]. Infection usually occurs after the ticks have been present on the human body for 24-48 hours. It is important to remove the tick as soon as possible [9]. Tick-borne diseases, including Lyme disease and tick-borne encephalitis, which most often affect humans, are associated with many clinical difficulties. The antigenic heterogeneity of the genomes that causes Lyme disease in Europe makes diagnosis very difficult, and often not clear. There are numerous problems that hinder the treatment of Lyme disease, such as the rapid spread of spirochetes and their rapid penetration of the central nervous system (CNS), their ability to infect almost all tissues, their ability to avoid the immune response of the infected host, their ability to cause chronic infections that last for months or even years, and the induction of neurologic-psychiatric syndromes (such as fibromyalgia and chronic fatigue syndrome), which are difficult to treat [3]. Serious effects can occur due to complications after previous infections with *B. burgdorferi* that can be observed for a long time (up to several decades) after infection. These complications may include changes in the CNS (e.g., various degrees of memory impairment), changes in the musculoskeletal and circulatory systems, and neurological/psychiatric issues (neurosis, depression, irritability, drowsiness, and psychogenic syndromes) [9]. The symptoms of Lyme disease are extremely diverse, nonspecific and change over time, causing diagnostic and therapeutic problems. Erythema migrans (EM) at the bite site is the only symptom that occurs in approximately 70 to 80 percent of people with Lyme disease [10]. EM is a typical symptom that indicates the development of Lyme disease. Some symptoms also resemble those of other diseases. Although EM is a characteristic clinical symptom of Lyme disease, it does not occur in all patients. In addition, Lyme disease often occurs concurrently with other tick-borne infections (i.e., tick-borne diseases and spirochete infections) and other comorbidities. In the case of multipathogen infections (tick-borne diseases or comorbidities), it is difficult to determine the pathogen causing the dominant symptoms, as Lyme disease presents differently in different individuals, and coinfections that modulate the patient's immune system (including a flulike illnesses that involve chronic fatigue, fever, headache, chills, joint aches, and swollen lymph nodes) may complicate the clinical picture [3].

Frequency of occurrence

The highest incidence of Lyme disease occurs in central Europe (e.g., in Slovenia it is 155/100,000), and the lowest incidence occurs in the United Kingdom (0.7/100,000) and Ireland (0.6/100,000) [11]. In France, the average annual incidence of Lyme disease in 2004-2012 was 42/100,000 and ranged from 0 to 184 per 100,000 inhabitants, depending on the region [11]. Since 1997, Lyme disease cases have been compulsorily reported and registered in Poland. According to the data of the Chief Sanitary Inspectorate in 2018, the incidence of Lyme disease in Poland was 55.9 per 100,000 inhabitants [5]. In Poland, there has been a steady increase in the number of tick-borne diseases since 2013, and the phenomenon of tick-borne diseases has become a significant and growing problem in Poland. In 2018, 20,139 Lyme disease cases were reported [5]. The number of Lyme disease cases detected in Poland has shown a general upward trend [12]. Disease caused by *B. burgdorferi* is believed to be underestimated due to its nonspecific symptoms [12,13] and according to the data from tests for the presence of antibodies.

Strategies for the primary prevention of Lyme disease worldwide

The therapeutic difficulties mentioned above demonstrate the need for methods to significantly reduce the risk of developing tick-borne diseases. Due to the increasing number of *Borrelia* infections, there is a significant need to suppress further pathogen expansion [14].

Specific prophylaxis methods such as vaccination can only be used for tick-borne encephalitis virus [15]. For other tick-borne diseases, no effective vaccine has been developed. A vaccine against Lyme disease was available on the American market from 1998-2002, but it was withdrawn due to numerous public concerns about its side effects [12]. Currently, research continues to focus on developing a new vaccine, the so-called anti-tick, to protect against several tick-borne diseases [15].

The World Health Organization (WHO), as an international health policy leader, makes every effort to create strategies to improve health awareness and behavior to protect against vector-borne diseases and infections. The celebration of World Health Day (April 7) creates the opportunity to take numerous actions that will result in improving human health. The theme of World Health Day in 2014 was related to vector-borne diseases: "A small bite, a big threat". To address the topic of vector-borne diseases, as described by the WHO, it is critical to increase the level of knowledge and health awareness of individuals living in highest-risk areas and those who travel to countries with pathogenic vectors [16]. The report outlined a strategic approach to prevent infection and combat vector-borne diseases, including those caused by tick-borne infections. Best practices for disease prevention and control and challenges for public health specialists were also presented. The WHO promotes an integrated approach to control, protect and combat vector-borne diseases via close cooperation between partners in the global public health community at the governmental, ministerial, household and nonprofit organization levels [17].

Additional WHO activity related to the field of vector-borne disease prophylaxis resulted from the adoption of the global vector control response for 2017-2030 (GVCR: 2017-2030) at the 139th meeting of the WHO World Board of Health (Executive Board), which took place in May 2016 [17]. The strategy aimed to reduce comorbidities and risks of vector-borne diseases through effective, locally adapted and balanced vector control. The future success will depend on countries' ability to readjust and strengthen their vector control programs with the necessary staff and financial resources. The WHO encourages changes to national strategic plans and setting country-specific goals. The GVCR presented a new strategy that aims to strengthen the control of vectors worldwide by increasing capacity, improving supervision and coordination, and integrating operations.

The strategy is included in the scope of activities developed by the UN 2030 Agenda for Sustainable Development. Its implementation and realization will directly contribute to the achievement of objectives no. 1, 3, 6, 11, 13 and 17 that are specified in the document entitled Sustainable Development Goals, which focus on combating poverty, ensuring health and quality of life, clean water and sanitary conditions, sustainable urban and community development, climate action and partnerships for goals, respectively [18]. A newly published global report on vector-borne diseases presented an action strategy that should be undertaken by governments, social groups, families and households to ensure protection against the risk of vector infection [17].

At the EU level, the European Emerging and Vector-borne Diseases (EVD) program is being implemented for vector-borne diseases. It was developed by the European Center for Disease Prevention and Control (ECDC) for 2014-2020 [19]. The main goal of the EVD program is to strengthen EU-wide strategies for the prevention and control of emerging and vector-borne diseases.

This program provides member states with the access to expertise, up-to-date risk assessments of these diseases for EU citizens, and a wide range of decision support tools in line with the latest scientific knowledge.

The program team closely cooperates with experts in various scientific fields and relevant entities in the field of vector-borne diseases [i.e., relevant bodies of the European Commission, the European Food Safety Authority (EFSA) and international organizations such as the WHO. At the same time, the set of materials prepared by the ECDC as communication tools for vector-borne diseases (Guidance: ECDC Communication Toolkit on Tick-borne Diseases) allows a coherent and comprehensive educational campaign [19]. The main goal of the ECDC program on tick-borne diseases is to help EU member states with their efforts to raise awareness of the health risks associated with tick-borne diseases among target audiences and to encourage the adoption of preventive measures to reduce the risk of developing tick-borne diseases. This toolkit includes a set of materials on tick-borne diseases, how they spread, actions to take in the event of tick bites and disease symptoms, which were designed to provide entities responsible for creating national health policy with the necessary information. The developed tools were designed to protect the EU from infectious diseases through the identification, assessment and communication of current and emerging threats for human health caused by infectious diseases. They also help to promote the exchange of best practices in the prevention of these diseases [19].

Strategies for the primary prevention of Lyme disease in Poland

At the national level, the basic legal act referring to the issue of infectious diseases is the Act of 5 December 2008 on preventing and combating infections and infectious diseases in humans [20]. According to this legislation, doctors who suspect or recognize tick-borne diseases are obligated to report them within 24 hours to the Sanitary State Superintendent or Regional Health Inspector for the place of diagnosis [20]. The registration of incidence is the basis for conducting epidemiological analyses and educational campaigns.

The main entity that carries out activities in the field of prevention and health education in Poland is the Chief Sanitary Inspectorate (GIS). Its duties are to organize, conduct, coordinate and supervise educational and health activities in order to develop appropriate attitudes and health behaviors [21]. In the season from March to the end of November, the risk of infection is high, therefore the GIS conducts information campaigns associated with the risk of tick-borne diseases and their prevention [22]. The most important information on infectious diseases and infections, which is also relevant for travelers, is posted on the website of the GIS. This information is constantly updated and adapted to emerging epidemiological threats in Poland and worldwide. Every year, GIS campaigns address the dangers of tick exposure and bite management. The purpose of campaigns undertaken by GIS is to provide information on how to deal with a bite and to become aware of the risks and dangers involved. The GIS emphasizes that tick bites are often not noticed by humans due to the anesthetic properties of tick saliva. Therefore, preventive measures are important. The GIS prepared a short cartoon in 2016 entitled "Watch out for ticks!", which shows what to do in the case of a bite [23]. The recommendations were given in the form of a hip-hop song.

In addition, territorial units of the GIS take actions within the frameworks of programs initiated and carried out in voivodeships and districts throughout the country. In 2011, the GIS granted patronage for the nationwide educational program entitled "Both big and small ticks are bad news" organized by the Foundation "Fundacja Aby Żyć". At this point, one should also describe the To Live Foundation (Fundacja Aby Żyć), which was established to promote preventive measures in Poland related to the risk of nervous system infectious diseases, among other things [24]. The foundation also focuses on the prevention of tick-borne diseases. It has the status of a Public Benefit Organization, is a member of the Confederation of Meningitis Organizations and cooperates with many entities that are involved in preventive health care, such as the Ministry of Health, the WHO and the International Association of Medical Students. One of the foundation's activities in the field of tick-borne diseases are yellow warning signs that appear in green areas [22].

The GIS also cooperates with the National Forest Information Center on preventive activities. On 29 May 2014, a joint conference was organized entitled "How to use the forest safely", which discussed issues related to tick-borne disease prophylaxis [23]. The National Forest Information Center (CILP) also undertakes activities in the field of societal health and ecological education. In relation to the WHO campaign, the Directorate-General for the National Forest Information Center prepared educational materials entitled "Small bite, big problem" [23].

The Polish Society of Epidemiologists and Doctors of Infectious Diseases also deals with the prevention, diagnosis and therapy of tick-borne diseases – in particular Lyme disease. The operating principles are based on the recommendations of the Infectious Diseases Society of America (IDSA) [25].

In the context of the implementation of international, European and national goals related to assumptions regarding the reduction of negative effects of tick-borne diseases, it is necessary to carry out an in-depth analysis of factors that determine the effectiveness of preventive actions that are taken, particularly health education.

Public health activities that are primarily aimed at increasing public health awareness are of great importance. It is crucial not only to search for effective methods to treat diseases caused by *Borrelia* spirochetes but also to develop prevention activities in phase I, II and III. Preventive actions against Lyme disease should primarily focus on increasing health awareness among the population, which will help to improve protective behavior, as well as the use of nonspecific methods of protection against these arthropods. Health education is a basic element of preventive programs, especially as specific prevention in the form of a preventive vaccine against Lyme disease is currently not available [26]. Educational intervention for the prevention of tick-borne diseases is justified because it helps to improve preventive behaviors related to tick-borne diseases. This hypothesis has been confirmed by numerous scientific reports that indicated that the knowledge of the principles of protection against infection significantly reduce the risk of developing tick-borne diseases.

In a study conducted by Lawless and colleagues, an instructional video was used to improve knowledge, attitudes and behaviors related to the prevention of Lyme disease in young people from four cities in Connecticut [26]. The authors concluded that the level of health awareness among adolescents improved after a month, while a decrease in the acquired knowledge was observed after 6 months. Importantly, progress has been made in terms of preventive behaviors. Adolescents claimed that they would employ protective measures both one month and six months after watching the movie about tick-borne disease. Therefore, the level of knowledge, despite its obvious instability, translates into the consolidation of positive actions in the field of infection prevention [26].

Additionally, in studies by Malouin and colleagues from 2003 [27] and Daltroy and colleagues from 2007, the effectiveness of undertaken educational activities was noted [28]. After conducting educational campaigns, there was an improvement in the use of personal protective equipment, including the use of repellents, more careful checking of the body for tick bites and avoiding areas where these arthropods are found [28].

Research conducted in Poland among the professional groups that are at the highest risk of tick-borne infection indicated that the sources of knowledge for the respondents were primarily books, brochures, posters and vocational education [29]. Additionally, in research carried out by the Institute of Agricultural Medicine in Lublin from 2004-2005, it was noted that educational campaigns were the main source of knowledge for foresters. According to the respondents, an educational campaign on the principles of protection against the infection risk by ticks is necessary for foresters [29].

In 2010, Maat and Konings conducted a survey of 600 Dutch residents that indicated that many respondents were not able to recognize and remove ticks [30]. In addition, they reported that problems related to the risk of tick bites did not apply to them, so the use of protective measures was unnecessary. Maat and Konings provided new solutions in their study that should be included in health programs. The study showed that knowledge, the level of interest and perceived effectiveness are the main determinants of preventive behavior. Therefore, future prevention programs should focus on these determinants. According to research by Maat and Konings, protective measures such as wearing protective clothing and the use of insect repellents are not used. One should remember to mention the need for protective measures in educational campaigns. As indicated by the authors of the study, it is also important to adapt the information to specific sociodemographic subgroups and high-risk groups [30].

On the basis of the research reports, the Dutch National Institute for Public Health and the Environment created a nationwide information campaign on ticks and Lyme disease. The campaign did not cover all possible preventive measures and focused only on providing information on thorough body checks and possible tick removal [31].

In addition, the educational game "Teekcontrol.nl" was also developed. The goal was to reach a wider audience, primarily children and teenagers. Over 30,000 children used the game within 8 months of its introduction [32]. The educational effect of the game was assessed in 2012. The analysis of its effectiveness indicated that the game became an effective tool for improving preventive behavior. The frequency of checking for ticks on the body significantly increased. The conclusions indicated that the game has important value for conducting educational campaigns among children. Researchers indicated that the game focused on preventive behavior determinants, according to the theory of protection motivation. This theory assumes that the "threat assessment" is created by the individual based on the perceived probability of the occurrence of a specific event. This theory has been confirmed by research conducted by Herrington and Mowbray, who indicated that the effectiveness of educational campaigns depends on the promotion of both knowledge and behavior that positively influences the attitude of recipients towards educational campaigns on tick-borne diseases [33].

Research carried out in Canada and Switzerland in 2012 by Aenishaenslin and colleagues confirmed that social factors are important for designing effective educational campaigns for Lyme disease [34]. This study compared the importance of knowledge, exposure and risk perception in the context of adopting individual preventive measures. The conclusions of the study showed that awareness of infection risk among the population may

increase the acceptance level of suggested preventive behavior in regions with Lyme disease [34]. Therefore, the perceived effectiveness of a specific preventive measure can be a reliable prognostic factor for the adoption of such measures in educational campaigns.

The role of mass media, in particular the role of the internet in the 21st century, is becoming a key element in driving human health behavior. The internet, which is considered a modern health educator, has become the main source of health information. Internet use is a permanent element of everyday functioning among modern human beings. The forecasts indicating that the internet would become a leading health educator were confirmed at the beginning of the 21st century [35]. The internet is growing at a break-neck speed. According to a pan-European study, Europeans are keen to apply online health information [34]. Over 75% of respondents believe that the internet is a good way to obtain health information. Six out of ten Europeans use the internet to search for health information, and 90% of respondents claimed that the internet had helped them improve their knowledge of health issues. A Polish study entitled "Trends in using the internet for health purposes in Poland" indicated that in 2007, 46% of Poles used internet sources to diagnose their own health disorder. In addition, the author observed that between 2005 and 2012, there was a 25% increase in the frequency of Polish people using the internet for health purposes [36].

Social media effectively disseminates information, making it of key importance to health communication. Many health-related movies are uploaded, searched and viewed daily. In 2016, Basch analyzed one of the most-visited websites on Lyme disease [37]. It turned out that 10 million views on YouTube™ were associated with Lyme disease. Forty of the 100 most-viewed YouTube videos on Lyme disease were posted by amateurs. Only 16 were created by medical professionals. Corey H. Basch's analysis suggested that many YouTube videos related to Lyme disease that were made by public health professionals were not popular enough to be included in the 100 most-watched videos [37]. Responsible television reports and innovative films created by public health specialists can utilize the untapped potential of YouTube to facilitate health education concerning Lyme disease.

Conclusions

Creating new ways to implement preventive actions, including those related to the problem of tick-borne diseases in humans, should take into account a number of factors that determine their effectiveness. It is necessary to create programs that cover a wide spectrum of activities and build effective educational strategy projects to effectively prevent the health and social effects of increased disease incidence. The level of public knowledge regarding the methods and risks of tick-borne disease translates into the consolidation of positive actions in the field of infection prevention. It is therefore necessary to promote both knowledge and appropriate preventive behaviors. To have measurable effects, educational activities must increase the level of awareness regarding the prevalence of tick-borne diseases, including Lyme disease. The change in the perception of the use of preventive methods, such as believing that clothing protection or insect repellents are ineffective, will contribute to the increased use of these measures. It is also important to adapt the information provided to specific sociodemographic subgroups and high-risk groups. In this regard, it may be helpful to use new media outlets, in particular social networks, on the internet. The use of new technologies can help in the fight against many modern health threats, including the prevention of tick-borne diseases. It has become necessary to undertake further research on determinants of the effectiveness of educational and preventive measures, notably by taking into account the specificity of the message through new media outlets.

Disclosures and acknowledgements

This work and paper were funded by the authors' own resources. The authors declare no conflicts of interest.

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