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## Research

# Framework for Primary Prevention of Emerging Climate-Sensitive Diseases through the Lens of Planetary Health: The Case of Lyme Disease in Canada and Quebec

*Cadre de prévention primaire des maladies émergentes sensibles au climat à travers le prisme de la santé planétaire : le cas de la maladie de Lyme au Québec*

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## Abstract

This article contextualizes climate change and its impact on population health by highlighting the emergence of climate-sensitive infectious diseases. Using Lyme disease in Quebec as an example, it aims to achieve two objectives. First, the article demonstrates that the Quebec, and even Canadian, healthcare system is deficient regarding accessibility to treatment for this disease. Consequently, it emphasizes the need to optimize population health by proposing the enhancement of this pathology's preventive dimension by defining an intervention framework focused on planetary health. To this end, we defined a methodological approach based on a narrative review and the mobilization of some media sources. The results of this review suggest that the controversies surrounding diagnoses and treatments justify the inherent difficulties in accessing care. This, in turn, demonstrates the limitations of the healthcare system in Canada particularly in Quebec. The article highlights the necessity of strengthening primary prevention strategies by mobilizing planetary health as the main preventive framework. Thus, the results of the narrative review have allowed us to define preventive intervention strategies based on planetary health. These defined strategies form the proposed preventive framework to guide the primary prevention of climate-related diseases, particularly Lyme disease. These include ecosystem preservation, combating climate change, community education and awareness, adoption of preventive behaviors, sustainable agriculture and biodiversity, and environmental monitoring.

**Keywords:** Primary prevention, climate change, Lyme disease, planetary health, emerging disease, controversies, diagnostics, access to care.

## Résumé

Cet article met en contexte le changement climatique et son impact sur la santé des populations en mettant en lumière l'émergence des maladies infectieuses sensibles au climat. En prenant comme exemple la maladie de Lyme au Québec, il vise deux objectifs. Tout d'abord, l'article montre que le système de soins québécois, voire canadien, est défaillant par rapport à l'accessibilité aux de traitement de cette maladie. Par conséquent, il met ensuite en avant la nécessité d'optimiser la santé des populations en proposant le renforcement de la dimension préventive de cette pathologie à travers la définition d'un cadre d'intervention axé sur la santé planétaire. Pour ce faire, nous avons défini une démarche méthodologique basée sur une revue narrative et sur la mobilisation de quelques médiatiques. Les résultats de cette revue permettent de considérer que les controverses entourant les diagnostics et les traitements justifient les difficultés inhérentes à l'accès aux soins. Ce qui, par conséquent, démontre les limites du système de soins au Canada et au Québec en particulier. À cet égard, l'article démontre la nécessité de renforcer les stratégies de prévention primaire en mobilisant la santé planétaire comme principal cadre préventif. Ainsi, les résultats de la revue narrative ont permis de définir à partir de la santé planétaire des stratégies d'intervention préventive. Ces stratégies définies forment le cadre préventif proposé pour guider la prévention primaire des maladies d'origine climatique notamment la maladie de Lyme. Il s'agit de : la préservation des écosystèmes ; la lutte contre le changement climatique ; l'éducation et sensibilisation communautaire ; l'adoption des comportements préventifs ; l'agriculture durable et biodiversité ; et de la surveillance environnementale.

**Mots clés :** Prévention primaire, changement climatique, maladie de Lyme, santé planétaire, maladie émergente, controverses, diagnostics, accès aux soins.

## Introduction: Context and Issues

Climate change refers to the set of modifications in the planet's climate compared to a previously observed situation (Chaix & Slama, 2022). These changes are anthropogenic in origin (Du, Kawashima, Yonemura, Zhang, & Chen, 2004; McMichael, Woodruff, & Hales, 2006). Indeed, the notable and perceptible effects resulting from the increased and continuous climate variability affect several areas, particularly health, through the emergence and resurgence of climate-sensitive infectious diseases (CSIDs) (Denys & Barouki, 2021; Milord, 2010). In Canada, for example, it has been demonstrated that climate change leads to the emergence of infectious diseases, notably Lyme disease, which is spreading northward from the United States (Ogden & Gachon, 2019). In this perspective, several emerging pathologies have been identified and categorized based on their sensitivity to climate change (Balato et al., 2014; Patz, Campbell-Lendrum, Holloway, & Foley, 2005). The increase in CSID cases is explained by deforestation, rising temperatures, and the intensity of precipitation, which are conditions conducive to the survival of ticks and other vectors (Nava, Shimabukuro, Chmura, & Luz, 2017; Patz, Olson, Uejio, & Gibbs, 2008). The devastating effects of climate change have disproportionate impacts on population health, exacerbating health inequalities and injustices (Guivarch & Taconet, 2020). In this regard, a significant body of literature considers Lyme

disease (LD) as one of the emerging agents sensitive to climate disruption (Gasmi et al., 2017; Lindgren & Jaenson, 2006; Nelder et al., 2018; Nick H. Ogden et al., 2019; Simon et al., 2014). It is important to note that this disease is part of a chronic dynamic coupled with great complexity regarding its treatment (Marques, 2022). LD is an infectious disease transmitted by the bite of ticks infected with *Borrelia* and can develop through several phases (Marchitto, 2017). Commonly observed symptoms include arthritis, erythema migrans (Gasmi et al., 2017), neurological symptoms (e.g., facial nerve paralysis and meningitis), cardiac symptoms (Ray et al., 2013), as well as flu-like symptoms such as fever, fatigue, headaches, and others (Gasmi et al., 2017). Thus, the main problem inherent to this pathology is that there are no objective and indisputable diagnostic biomarkers. This absence can contribute to the stigmatization of patients, making the diagnosis more subjective and controversial, and consequently, access to healthcare more difficult (Levesque & Klohn, 2019). Indeed, the issues inherent to the controversies surrounding the diagnosis and treatment of LD highlight the failure of the healthcare system, characterized by limited clinical knowledge (Beard, 2014; Guilbaud, 2019). This situation creates the stigmatization of certain patients (Brown et al., 2018) and undermines health equity. It should be noted that the climatic and environmental conditions surrounding the emergence of Lyme disease and their impacts on human health could be understood through the lens of planetary health. It is defined as: “the achievement of the highest attainable standard of health, wellbeing, and equity worldwide through judicious attention to the human systems—political, economic, and social—that shape the future of humanity and the Earth’s natural systems that define the safe environmental limits within which humanity can flourish. Put simply, planetary health is the health of human civilization and the state of the natural systems on which it depends” (Whitmee, Haines, Beyrer, et al., 2015). In this regard, it should be noted that while our issue highlights the limitations of the curative system, planetary health could be mobilized to strengthen the preventive dimension of this disease. Therefore, the question arises: how can planetary health be mobilized as a preventive intervention framework to limit the increase in Lyme disease cases? To this end, the main objective of this article is to contribute to the fight against emerging climate-sensitive diseases, particularly Lyme disease, by first identifying the limitations of the healthcare system and then proposing a primary prevention framework. From this general objective, two specific objectives arise: 1) to review the scientific literature that presents the various limitations of the healthcare system in managing emerging climate-sensitive diseases, using the example of Lyme disease in Quebec; 2) to present, based on relevant scientific knowledge, a preventive intervention framework based on the principles of planetary health to limit the increase in Lyme disease cases.

This article is organized into four parts: 1) A brief description of the adopted methodology; 2) an Analysis of the various results demonstrating the limitations of clinical knowledge and the notable flaws of the curative system; 3) Presentation of the preventive framework based on planetary health; 4) Discussions on the dimensions of planetary health in the context of preventing emerging climate-sensitive diseases, particularly Lyme disease.

## **1) Methodology Adopted**

We conducted a narrative review to achieve the two specific objectives defined above. For this purpose, we used the year 2000 as a reference point and utilized Google Scholar as the main research tool. Additionally, databases such as Cairn and PubMed were used, highlighting specific keywords. For the first objective, we used keywords such as Lyme disease, access to care, diagnostics, treatments, and Quebec. Some media analyses were also conducted based on the defined keywords. Regarding the second objective, the keywords used were: planetary health, principles of planetary health, prevention, climate change, emerging climate-sensitive diseases. Using NVivo as an analysis tool, we first coded the different themes (related to diagnostics, access to care, treatments, and Quebec). Then we grouped the relevant textual excerpts directly related to them. Analyzing the content of our narrative review, it appears that the limitations of the healthcare system in effectively managing Lyme disease are mainly explained by the controversies inherent to the chronicity of Lyme disease, diagnostics, and consequently, the difficulty in accessing care. Similarly, the narrative review documented the principles of planetary health from a perspective rooted in the prevention of Lyme disease to contribute to reducing the increase in cases. As with the first specific objective, we also used NVivo as an analysis tool for the second objective, following the same process as mentioned above. Thus, the analysis results identified five themes in the form of intervention actions. These five intervention themes form the basis of the preventive framework we presented. They are: ecosystem preservation; combating climate change; sustainable agriculture and biodiversity preservation; environmental monitoring; community education and awareness. In the following sections, we will further develop these different results related to specific objectives one and two.

## **2) The Limitations of the Healthcare System and the Management of Lyme Disease**

To better understand the issue of Lyme disease management, we conducted a narrative review. This review's results highlighted the healthcare system's limitations in Canada, particularly in Quebec. These results allowed us to achieve the first specific objective, which is: the chronic dimension of Lyme disease is highly controversial; several controversies surround the diagnosis and treatment. Consequently, people with Lyme disease face difficulties in accessing adequate treatment.

### **2-1 The Chronic Dimension of Lyme Disease and Its Controversies**

Regarding Lyme disease, a vector-borne disease, it should be noted that most epidemiological aspects, clinical manifestations, and treatment of Lyme neuroborreliosis are well known and accepted (Koedel, Fingerle, & Pfister, 2015). However, several studies have shown that the chronic dimension of this disease is surrounded by considerable controversy (Garakani, 2015; Barbour, 2012; Koedel et al., 2015; Matera et al., 2014). These controversies inherent to the chronicity of Lyme disease highlight the limited clinical knowledge regarding this disease. In France, Lyme disease is only officially recognized in its acute form. However, its chronic form,

painful, disabling, and difficult to treat, long denied, has recently been half-heartedly recognized by some scientists (Guilbaud, 2019). Despite this relative recognition by scientists, “the French Society of Infectious Pathology (SPILF) and, under its aegis, the majority of doctors persist in denying the existence of this chronic form (Guilbaud, 2019). SPILF doctors do not propose any other explanation for the sometimes extremely severe pain suffered by patients nor any effective treatment” (Guilbaud 2019, 107). Consequently, the current official recommendations and various oppositions on this disease do not allow patients to benefit from universally recognized care (Marchitto, 2017a; Massard-Guilbaud, 2019). In Canada and Quebec, recent Lyme disease studies highlight growing management challenges. The disease is spreading northward at 18 to 32 km/year, and the incidence and burden are expected to increase by 2050 due to climate change (Ripoche et al., 2023; Tutt-Gu erette et al., 2021). Thus, in Canada and Quebec, although 99% of patients show clinical resolution after treatment, it is important to note that post-treatment Lyme disease syndrome is still increasing (Musonera et al., 2022). In this regard, controversial debates persist regarding tests, treatment, and the chronicity of Lyme disease (Levesque and Klohn, 2019). This situation leaves “affected individuals to fend for themselves within the healthcare system” (Beaulieu 2020, n/d).

## **2-2 Controversies Related to Lyme Disease Diagnostics**

There is no consensus regarding the two possibilities for diagnosing Lyme disease. These possibilities are clinical analyses and serological tests (Levesque & Klohn, 2019). Diagnosis through clinical analysis occurs if the patient presents with erythema migrans and has plausible exposure, meaning the focus is rather on exposure to the emergence of the disease in areas where it was not previously endemic, regions where public health and clinicians may not have followed the increase in disease prevalence instead of focusing on the patient’s clinical condition (Ogden, Lindsay, Morshed, Sockett, & Artsob, 2009). Thus, for some, a positive diagnosis requires the presence of erythema migrans (Andany, Cardew, & Bunce, 2015). However, it should be noted that relying too much on the presence of erythema migrans is problematic due to its great variation among people with Lyme disease (Levesque & Klohn, 2019). Thus, if the patient does not suffer from erythema migrans, Levesque & Klohn (2019) believe that they must undergo positive serological tests to detect the presence of antibodies against the Lyme disease bacterium (in most cases, even if they have been exposed to areas with high tick populations). These authors also point out that Canada follows the Centers for Disease Control and Prevention (CDC) protocol for serological tests, starting with the enzyme-linked immunosorbent assay (ELISA) test and, if positive, verifying via a Western blot test. However, screening tools, particularly the ELISA test, do not guarantee the reliability of the results (Birnbaum, 2014; Depietropaolo, Powers, Gill, & Foy, 2005), especially in the early stage of the disease (Aguero-Rosenfeld, Wang, Schwartz, & Wormser, 2005). It should be noted that screening tests look for antibodies that the body might produce in response to a vector-borne infection caused by a tick (Andany et al., 2015). However, these tests have low sensitivity regarding the early detection of Lyme disease, as the immune response is in its early stages of development (Andany et al., 2015). In this regard, serological tests for diagnosing early Lyme disease are known for a high rate of “false negatives” due to their sensitivity estimated at only

40% (Andany et al., 2015). Some researchers have also criticized the current two-tier screening system for Lyme disease in Canada (Boudreau, Lloyd, & Gould, 2018; Waddell et al., 2016). For example, Ogden et al. hypothesized that the location and/or time of year when an infection is contracted may present variations in Lyme disease itself. They concluded that Lyme disease in Canada may vary between the east and west of the country, thus dividing it at the border between Ontario and Manitoba, probably due to the disease descending from two different strains (Nicholas H Ogden, Arsenault, Hatchette, Mechai, & Lindsay, 2017). Lloyd and Hawkins, for their part, believe that these geographical variations could partly explain the underreporting of the disease. Because some variations might not be detected with the current two-tier serological tests (Lloyd & Hawkins, 2018). These different points highlight the divergences surrounding this disease and complicate access to care.

### **2-3 Controversies Related to Treatments and Difficult Access to Healthcare**

Lyme disease is currently treated with various short-term antibiotics (10 to 28 days) that are widely accepted within academic and medical communities (Sanchez, Vannier, Wormser, & Hu, 2016). However, some patients and healthcare professionals advocate for longer antibiotic treatment periods due to the recurrence of symptoms after short-term antibiotic use, thus implying the chronic dimension of the disease (Auwaerter, 2007; Stricker, 2007). Around this chronic dimension, controversies are most persistent (Cameron, Johnson, & Maloney, 2014). It should be noted that the majority of the medical community disputes the existence of chronic Lyme disease for various reasons (Levesque & Klohn, 2019). Firstly, the controversies also concern categorization issues (post-treatment or late Lyme disease), symptom manifestation, and associated test results (positive/negative) (Auwaerter, 2007; Kowalski, Tata, Berth, Mathiason, & Agger, 2010). Secondly, there is a group of generally skeptical doctors who believe that some patients suffer from other diseases but think they have chronic Lyme disease (Auwaerter, 2007). Finally, some doctors oppose long-term antibiotic use due to perceived medical risks (Basu & Garg, 2018). According to Beard (2014, 98), “despite the controversy surrounding the treatment of patients with persistent symptoms associated with Lyme disease, experts agree that the best way to reduce severe clinical outcomes is to proceed with early and accurate diagnosis and treatment of the disease.” However, as noted earlier, tests are unreliable, especially in the primary stage (Aguero-Rosenfeld et al., 2005; Depietropaolo et al., 2005; Birnbaum, 2014). For Beaulieu (2020, 10), the real clinical problem is that patients “face difficulties in recognizing the existence of the disease and diagnosis.” This demonstrates that doctors have little knowledge about this disease. The main consequence is the stigmatization of patients (Brown et al., 2018) due to the unreliability of diagnoses. Indeed, a study published in 2023 examined 986 cases of Lyme disease. It highlights that the majority of cases are either undiagnosed or misdiagnosed. The same source indicates that symptoms are considered related to mental illness, anxiety, stress, and aging diseases (Fagen, Shelton, & Luché-Thayer, 2023). This situation drives some Canadian patients to seek necessary care in the United States (Boudreau et al., 2018). Succinctly, this literature teaches us that other symptoms can develop after treatment. In this regard, Garakani and Mitton (2015) refer to post-treatment symptoms such as panic attacks, severe depressive symptoms, and suicidal thoughts, as well as neuromuscular disorders, including back spasms, joint pain, myalgia, and neuropathic pain. Therefore, it should be noted that these symptoms and others, called “post-treatment Lyme

disease syndrome” (Koedel et al., 2015), which characterize the chronicity of the disease, are more controversial. In Canada, it should be noted that the principles of universality, accessibility, and comprehensiveness respectively require that every patient, without exception, can access all the health services and care they need for their well-being (Gilbert, Kérisit, Dallaire, Coderre, & Harvey, 2005; Vail, 2001). However, it is clear that people suffering from Lyme disease face difficulties in obtaining adequate diagnoses and treatments. To document these difficulties, Boudreau (2018) and colleagues conducted a study targeting forty-five patients from across Canada. The common point among these patients is that they all sought care outside the conventional Canadian healthcare system. Thus, the purpose of the article was to better understand their motivations. The results of the study highlight that the respondents sought care outside the conventional medical system due to numerous diagnostic procedures and treatments that failed to effectively address their symptoms. The worsening of health problems, the absence of effective treatment, and stigmatization caused patients to feel abandoned and hopeless. The respondents turned to other forms of care based on peer recommendations but experienced considerable financial and emotional stress. The conclusion drawn from this is that many people with Lyme disease are deeply dissatisfied with the care received within the conventional Canadian and Quebec healthcare system. They feel compelled to seek treatments from international doctors using different treatment protocols or from alternative medicine providers in Canada and Quebec (Boudreau et al., 2018). In the same perspective, another empirical study involving 23 parents of children and adolescents with Lyme disease reports that no satisfactory treatment was obtained for months or years (Gaudet, Gould, & Vett Lloyd, 2019). In conclusion, the authors propose improving diagnostic tests and treatment guidelines, as well as family-centered medical care practices, as important elements to improve the experience of families living with Lyme disease (Gaudet et al., 2019).

It should be concisely noted that Lyme disease remains a contested illness in Canada, making the diagnostic and treatment journey difficult for some individuals (Vassell, Crooks, & Snyder, 2021). However, in Quebec, it is fortunately noted that there are now specialized clinics for the treatment of Lyme disease. This would imply the recognition of this disease in Quebec. However, it is useful to specify that these clinics are extremely recent, so we do not yet have enough information to integrate their impacts on patient access to care. Consequently, this lack of information does not provide an opportunity to better understand the current and future systemic issues and organizational barriers related to access to care for people with this pathology in Quebec. In this regard, it is wise to ask: what are the reasons that could justify the problematic access to care despite the existence of specialized treatment clinics? In this regard, it appears that Stéphanie Lavoie, a 29-year-old Quebecer with Lyme disease, is unable to receive adequate care despite the existence of specialized clinics (Dumas, 2023). In her case, the main reason for her inaccessibility to care is that before accessing the services and care provided by these specialized clinics, one must be referred by a doctor, while Stéphanie does not have a family doctor (Dumas, 2023). Another media source highlights that treatment requires a doctor’s prescription (Dauphinais-Pelletier, 2023). Generally, it should indeed be noted that these structural limitations contribute to the difficult access to health care services in Canada and Quebec. Specifically, they affect Lyme patients and make their treatment difficult for two reasons. The first reason is that some patients do not have a family doctor who could

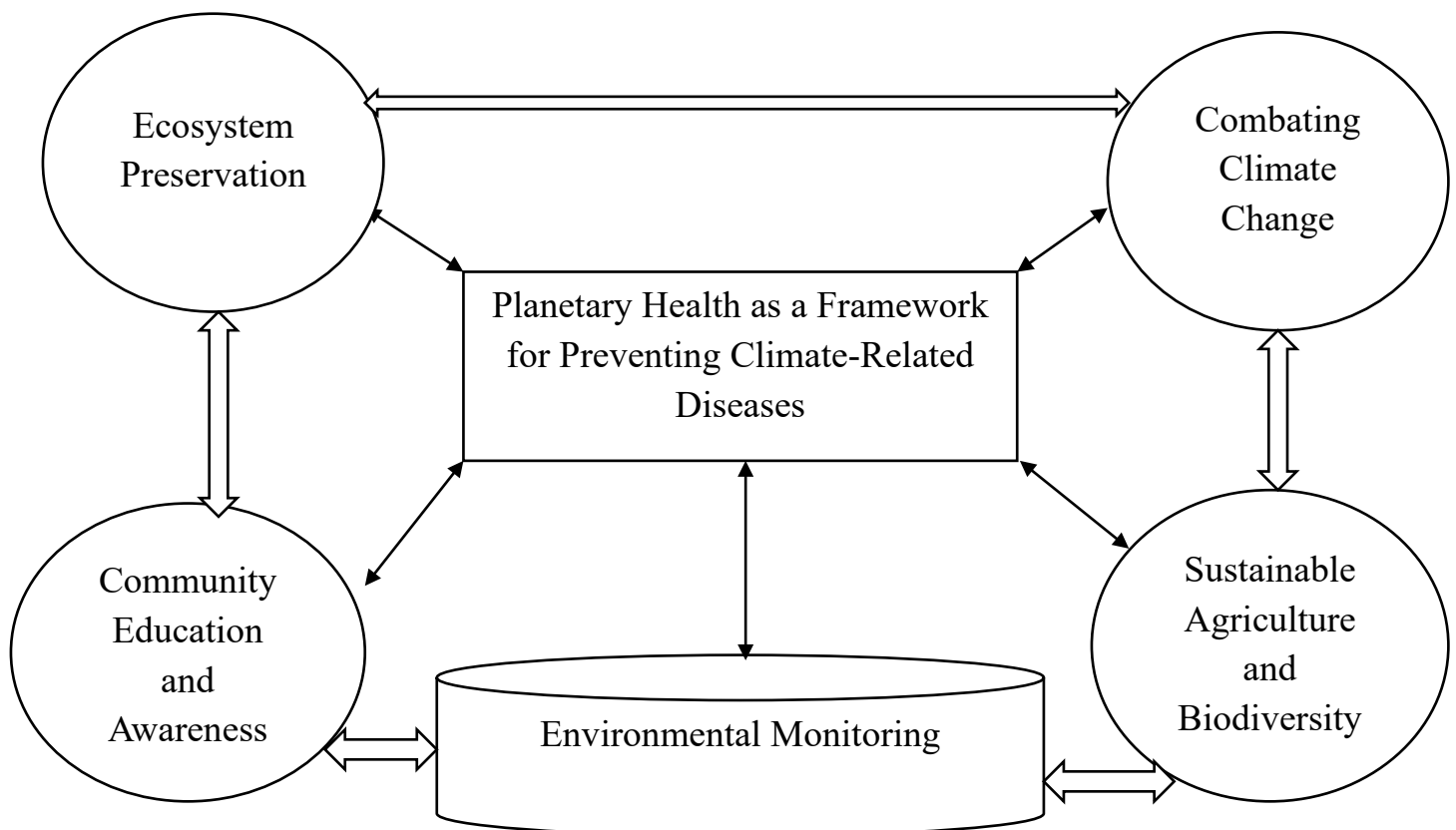
refer them to specialized clinics if needed (Dumas, 2023). Secondly, it has already been demonstrated that many doctors have difficulty making reliable diagnoses and administering adequate treatments. Moreover, the chronic dimension of Lyme disease is highly controversial and is therefore not recognized. As a result, even people with a family doctor may not be referred to these specialized clinics if their doctor does not recognize chronic Lyme disease.

From all the above, what can we retain from our narrative review? Four elements seem necessary to retain. Firstly, it should be noted that the difficult access to care inherent to Lyme disease is primarily related to the diagnostic and treatment issues explained by controversies. Recall that an accurate and reliable diagnosis is the first step in optimal management of Lyme disease (Pitrak, Nguyen, & Cifu, 2022). Indeed, problems abound, including diagnostic errors, the inability to obtain a diagnosis, or the persistence of symptoms after years of consultation and treatment with specialists (Boudreau et al., 2018). Early diagnosis and treatment are essential, but doctors' reluctance to do so constitutes a limitation that makes the Canadian healthcare system irrelevant in the face of adequate treatment of this disease. This, in turn, has led many Canadians and Quebecers to seek treatment in the United States at exorbitant costs (Levesque & Klohn, 2019). Regarding diagnostic issues, many parents report that despite suffering from Lyme, doctors dismiss their cases or give them other diagnoses related to mental health, asking them to see psychiatrists (Gaudet et al., 2019). These authors point out that patients are therefore forced to fight against the medical system to obtain low-quality diagnostic tests. The second element that complicates access to care for people with Lyme disease is the minimal knowledge of Lyme disease by healthcare professionals (Levesque & Klohn, 2019). The third element is the difficulty encountered by Quebecers despite the creation of specialized clinics for the treatment of Lyme disease. One of the conditions for treatment is to be referred by a doctor (Dumas, 2023). However, in Quebec, there are many Quebecers and immigrants who do not have easy access to family doctors (Déry, 2018; Dumas-Martin, 2014) who can diagnose patients before referring them to specialized clinics. This in itself also constitutes a barrier to easy access to care. The last element is that, faced with various systemic blockages, Quebecers who wish to seek care outside the country experience financial stress (Gaudet et al., 2019; Boudreau et al., 2018). These presented elements are important because the first two offer a solid explanatory weight related to the difficult access to care for people with Lyme disease before the establishment of specialized clinics. Then, the third opens the way to analyzing the difficulties encountered by patients after the creation of specialized clinics. Thus, these three elements justify the failure of the healthcare system and give credit to the need to focus more efforts on the primary prevention of climate-sensitive emerging diseases, particularly Lyme disease. As mentioned above, these lessons teach us that the curative system is not sufficiently efficient and that it is necessary to focus more on the preventive dimension to reduce the increase in cases.

### **3- Mobilizing Planetary Health as a Framework for Primary Prevention**

From the analysis of scientific literature (narrative review), it appears that planetary health can be mobilized as a framework for the prevention of climate-sensitive emerging diseases (Haines & Ebi, 2019; Myers, 2017; Watts et al., 2019; Whitmee et al., 2015). As mentioned above, we

retain that mobilizing planetary health as a preventive framework can be structured around several intervention approaches. These involve five themes: ecosystem preservation, combating climate change, sustainable agriculture and biodiversity, environmental monitoring, and community education and awareness. We mobilize them to propose the following framework to guide the primary prevention of climate-sensitive emerging diseases. This framework could be mobilized for the primary prevention of all climate-related diseases. However, in the context of this article, the framework is proposed primarily based on Lyme disease.



**Diagram: Planetary Health as a Framework for the Prevention of Climate-Related Emerging Diseases**

#### 4- Discussion: Mobilizing Planetary Health as a Preventive Measure for Lyme Disease

Planetary health is a holistic approach that highlights the link between human, animal, and ecosystem health (Myers, 2017; Whitmee et al., 2015). It recognizes that optimizing human health depends on several interdependent systems such as socioeconomic, political, ecological and environmental systems (Whitmee et al., 2015). Thus, the proposed framework is intended to be more general and could therefore be used for the prevention of all climate-related emerging diseases.

It should be noted that there are three types of prevention: primary, secondary, and tertiary. Loubière and colleagues define them as follows: “primary prevention represents all actions that reduce the occurrence or incidence of a disease [...]. Secondary prevention represents actions aimed at reducing morbidity or the consequences of a disease once it has appeared [...]. Finally, tertiary prevention represents actions aimed at reducing disability associated with chronic diseases” (Loubière, Parent, & Tallon, 2004, p. 831). In other words, primary prevention (preventing the occurrence of diseases by acting on risk factors), secondary prevention (early detection of diseases and rapid treatment), and tertiary prevention (avoiding complications through preventive measures) (Dekker & Sibai, 2001; Rassi, Dias, & Marin-Neto, 2009). Referring to these definitions, it is helpful to specify that the prevention we are discussing here is of a primary nature: preventing the occurrence of climate-sensitive emerging diseases in certain territories and/or reducing their spread. We therefore discuss the dimensions that feed the proposed framework, emphasizing their relevance in Lyme disease prevention, based on the results of our narrative review on the second objective.

### **3-1 Ecosystem Preservation**

The literature shows that deforestation and forest clearing coupled with increased urbanization dynamics disrupt the natural habitats of ticks, their hosts (deer, rodents), and natural predators (Allan, Keesing, & Ostfeld, 2003; Brownstein, Skelly, Holford, & Fish, 2005; Ostfeld & Brunner, 2015). In this regard, it is urgent, in a preventive dynamic, to implement measures consisting of restoring and preserving natural environments to contribute to the regulation of tick populations through healthy ecosystems and by establishing a balance between species (Allan et al., 2009; Ostfeld & Keesing, 2012). This intervention strategy is an integral part of reducing the fight against climate change.

### **3-2 Combating Climate Change**

Through our narrative review, it is demonstrated that global warming contributes not only to the expansion of areas where the presence of ticks has been detected but also to their survival through increased temperatures (Levi, Keesing, Oggenfuss, & Ostfeld, 2015; Nick H Ogden & Lindsay, 2016). In this regard, the primary prevention of Lyme disease requires the development of public policies to reduce greenhouse gas emissions and adapt to climate change to limit the spread of the disease (Medlock et al., 2013).

### **3-3 Community Education and Awareness for the Adoption of Preventive Behaviors**

Adopting a planetary health approach, it is essential to include community education and awareness to adopt precautionary measures regarding their interactions with the environment (Horton & Lo, 2015; Whitmee et al., 2015). This education and awareness approach should take place in already affected areas. It can be part of an inclusive dynamic allowing at-risk populations to significantly reduce their exposure to ticks and adopt individual protection and prevention behaviors (Gould et al., 2008). This can include, for example, the systematic use of repellents, avoiding wooded areas, wearing long clothing, and tucking pants into socks (Gould et al., 2008). Awareness for adopting the best individual behaviors should be coupled with collective actions focused on promoting and protecting the environment (Poland, 2001).

### **3-4 Sustainable Agriculture and Biodiversity**

Intensive agriculture and its practices contribute to the reduction of biodiversity, and consequently, increase the risks associated with the expansion of ticks (Foley et al., 2005). Indeed, intensive agricultural practices not only modify the ecosystem but also serve as an excellent means of eliminating natural predator species, allowing ticks to thrive and spread (Gortázar, Ferroglio, Höfle, Frölich, & Vicente, 2007; Keesing, Holt, & Ostfeld, 2006). In this regard, a sustainable agricultural policy based on increasing biodiversity is important from a perspective rooted in the primary prevention of Lyme disease. Indeed, a significant body of literature demonstrates that sustainable agricultural policies supporting biodiversity are necessary for maintaining and balancing tick populations and their hosts (Lanszki, Heltai, & Szabó, 2006; Schneider, Scheu, & Brose, 2012; Tschardt et al., 2012).

### **3-5 Environmental Monitoring**

The speed with which health systems can respond to the emergence of new climate-related diseases depends on the quality of the surveillance system in place in each country. In this logic, planetary health requires proactive interventions in monitoring ecosystems and animal species to quickly detect suspicious changes that could negatively impact human health (Myers et al., 2013; Whitmee et al., 2015). With active environmental monitoring, public health professionals should be able to detect, formulate rapid and diligent responses to minimize health risks to populations (Heymann & Rodier, 2004).

### **Conclusion**

The question this article seeks to answer is: how can planetary health be mobilized as a preventive intervention framework to limit the increase in Lyme disease cases? The answer provided is based on the idea that planetary health can be mobilized as a solid framework for the primary prevention of Lyme disease by simultaneously combining interventions focused on ecosystem preservation; combating climate change through mitigation and adaptation measures; community education and awareness for the adoption of preventive behaviors; sustainable agriculture and biodiversity enhancement; and environmental monitoring. It is important to emphasize that this answer is general in nature, meaning it can be applied in the context of preventing any emerging disease caused by climate change. The proposed framework thus takes on a theoretical dimension on which empirical research could be based to document the strategies each country or community implements for the primary prevention of climate-sensitive emerging diseases.

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