



Climate change projections and public health systems: Building evidence-informed connections



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1. Introduction

Climate change is unequivocally affecting human health and well-being due to on-going regional alterations to natural ecosystems and food production as well as damage to infrastructure, settlements, economies, and social-cultural networks [1,2]. The 2014 Intergovernmental Panel on Climate Change (IPCC) technical summary depicts significant vulnerability for populations across the globe due to shifts in weather patterns and climate variability. Data from climate change modelling can help predict human vulnerability to health risks and aid in the design and targeting of interventions within public health systems [3–5]. Yet, development and mobilization of climate data for use in public health requires strategic partnerships among researchers, practitioners and policy-makers who have traditionally worked in silos [6,7].

The objective of this short communication is to consider the health-related effects of climate change and to advocate for further development of interdisciplinary and practice-based research that connects climate change projections to potential human health vulnerabilities and informs practice and policy [2,3]. We use Lyme disease as a Canadian example of how climate change impacts vector-borne disease.

Research has shown that Lyme disease risk is continuing to increase in Canada as climate changes. Since the first diagnosed cases of Lyme disease in 2002, Canada's public health system has been responding to

the risks within its borders. Here we define the public health system as all public, private and voluntary entities involved in preventing disease and illness, promoting health and prolonging life among the population as a whole [8,9]. The Government of Canada has recently developed the *Action Plan on Lyme Disease* and has also enacted Bill C-442 the Federal Framework on Lyme Disease Act. Both serve as a platform for greater collaboration between provincial and territorial health authorities as well as with the medical community and patient groups. Further to the federal action plan and Bill C-422, provincial and territorial health authorities implement provincial response strategies to further reduce the burden of Lyme disease. These response strategies vary according to local, provincial, and federal contexts and can include enacting legislation, developing guidance documents, conducting surveillance, and disseminating Lyme disease related information to both the general public and health care professionals.

Although the Government of Canada and various provincial public health authorities have existing strategies in place to reduce the burden of Lyme disease, more research is needed to better understand the evidence-informed process of responding to climate change and its related health risks. Further research needs to include an evaluation of the existing response strategies in public health systems as well as an investigation of potential factors which may constrain or facilitate the planning and/or the implementation of strategies over time and across localities. Such research could inform the planning and implementation of best practice strategies in response to the ever-expanding health impacts of climate change [10].

2. Discussion

Significant human health impacts of a changing climate have been experienced across the globe. For example, the European heat wave of 2003 resulted in 30,000 to 50,000 premature deaths [11]. On-going prolonged droughts in several parts of the world including South Asia, Australia, and North-Eastern and West Africa have resulted in severe damage to infrastructure and settlements, extensive crop failures, premature deaths and migration of many refugees [2,11]. Human health-related impacts tend to be more severe in impoverished countries due to poor economies, socioeconomic structures, and currently fewer

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resources to adapt and respond to climatic changes. In developed countries such as Canada, researchers, health practitioners and decision-makers are making strides in working together to share knowledge and resources to build capacity within health systems and communities to address health concerns.

Human health effects of climate change include mortality and morbidity from extreme temperatures, droughts, flooding or storms. Respiratory and cardiovascular diseases can be associated with extreme temperatures and worsening air quality. Other climate-related health concerns can stem from threats to global water supplies and lack of clean drinking water as well as nutritional shortages caused by ecological disruptions such as crop failures and changes in food production [1, 12,13]. Further consequences include increased levels of emotional stress, anxiety and fear of the future, population displacement, civil unrest and conflict [14,15].

Climate change can also adversely impact human health through its potential to affect the distribution of vector borne diseases [16]. Changes in temperature, rainfall and humidity can directly affect vector reproductive rates, host-seeking activity, vector development and population density as well as biting [17–19]. Vector survival can also be affected by the abundance and range of host species and habitat suitability which are also sensitive to changes in climate factors [19,20].

Since its identification in North America in the 1970s, Lyme disease has become one of the most commonly reported vector-borne zoonoses in the temperate world [21–23]. Lyme disease is caused by the bacterium *Borrelia burgdorferi* [23]. *B. burgdorferi* is transmitted by ticks, which feed on wildlife reservoir hosts, such as rodents and birds. In humans, this bacterium causes a cutaneous phase marked by an acute febrile illness similar to influenza and is usually characterized by a bull's-eye rash [23,24]. If left untreated, the bacteria can move to multiple organs leading to neurological and cardiac symptoms and then to late Lyme disease with further neurologic manifestations and Lyme arthritis [23,24].

Ogden et al. [25] demonstrate that future climate warming will increase basic reproduction rates of *I. scapularis* in northern North America which will dramatically increase Lyme disease risk where it is already endemic, as well as extend the range into more northern regions where it is currently absent. For example, in the early 1990s only one documented endemic area of *I. scapularis* was known, namely Long Point on the Ontario shore of Lake Erie [23]. The majority of newly endemic areas are now found across central Canada and eastern Canada [26]. Leighton et al. [22] used surveillance data to demonstrate that Lyme vectors are spreading into Canada at a rate of 35–55 km per year and are following climate-determined geographic trajectories. In eastern Canada, tick populations are predicted to increase from 18% in 2010 to over 80% in 2020 [22,29].

3. Conclusion

Although all citizens are at risk for experiencing health-related impacts of climate change, some populations and regions have been identified as more vulnerable due to high exposure to climate hazards and limited capacity to adapt or cope [11,27]. Vulnerability depends on the rate and magnitude of environmental change, exposure levels and sensitivity, population demographics, and local adaptive capacity including social, cultural, political and economic conditions [11,27]. These conditions and contexts vary across provinces and territories in Canada. Thus, the distribution of the Lyme disease vector and the public health strategies to address increasing incidence of Lyme disease may differ among each province leaving some communities more vulnerable to the climate related impacts of *I. scapularis*. Research is needed to explore these differences – the fruits of this research may help propel and advise adaptation planning through the establishment of sustained dialogue and forums in which knowledge of existing strategies, adaptive capacity, perceived adaptation gaps, and best practices can be shared within and across localities [28]. Sustained, partnered

research and knowledge mobilization teams are needed to connect evidence of climate predictions and projected human vulnerability with practice and policy strategies for a context-dependent and localized approach to reducing and managing health risks.

Consensus exists among the scientific community that the global climate continues to change at an unprecedented scale of complexity and scope. Scientists across disciplines, policymakers, and health care professionals have a corresponding opportunity, perhaps even a moral imperative, to reconcile worldviews and collaboratively build and share knowledge alongside societal action.

Conflict of interest

The authors have not identified any actual or potential competing interests regarding the manuscript. There are no known conflicts of interest or financial conflicts.

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