Temperature, humidity may drive future transmission of parasitic worm infections

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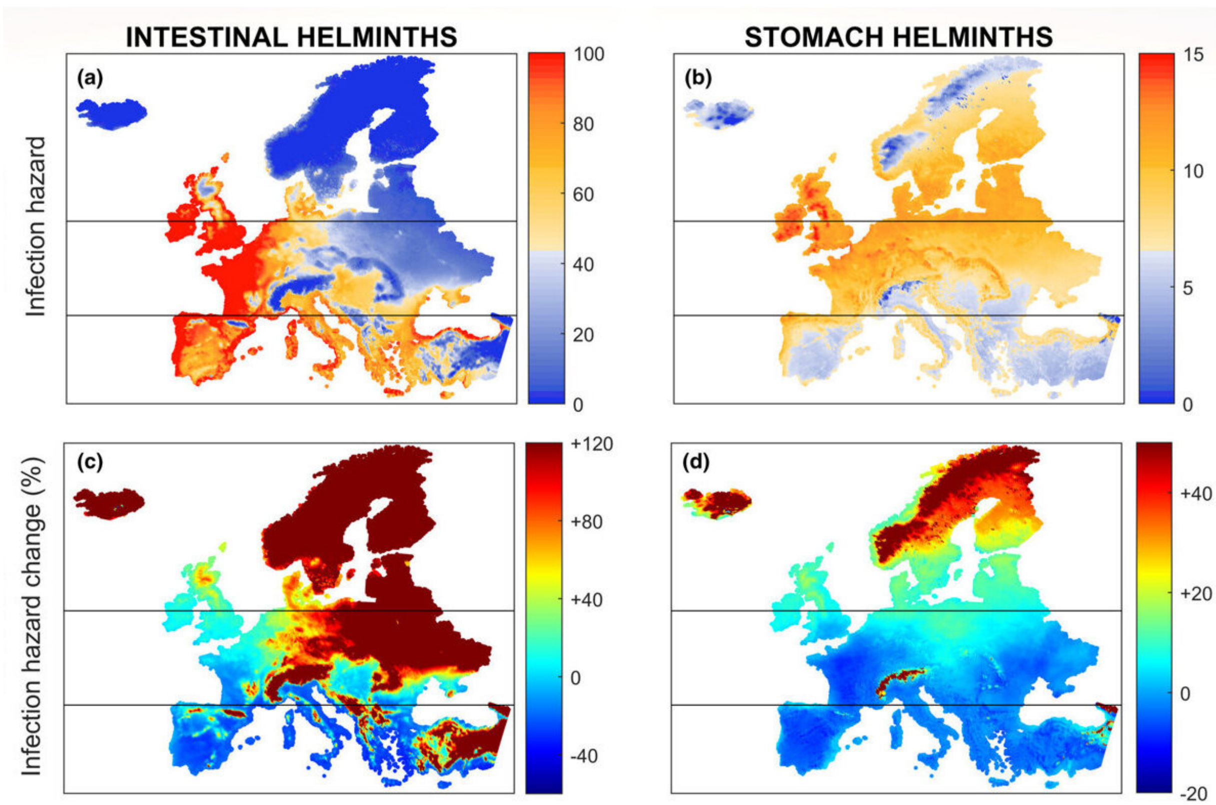

Average hazard of infection of intestinal (a, c, e) and stomach (b, d, f) helminths in the historical period (1981–2000, a, b) and expected percentage changes in the short-term (2041–2060, c, d) and in the long-term (2081–2100, e, f) under the RCP 4.5 climate change scenario. Horizontal lines separate northern, central and southern European zones. Dark red regions (c–f) correspond to both high increase areas and areas of helminth emergence. Credit: *Ecology Letters* (2024). DOI: 10.1111/ele.14386

As climate changes, temperature isn't the only factor to influence the spread of infectious diseases. Humidity plays a role, too, according to new research published this week (Feb. 25) in Ecology Letters.

The international team, led by Penn State researchers, developed a model to examine how parasitic worms, specifically species that infect livestock and wildlife, respond to changes in temperature and humidity and how those variables may shape the risk of infection and the development of new hot spots in the future. The findings, which may suggest similar behavior among worms that infect humans, could guide improvements in livestock management and public health interventions in endemic areas.

"We need to understand how climate change can affect the future of these infections," said Isabella Cattadori, professor of biology at Penn State and senior author of the study. "Are they going to get worse? Are they going to shift into different habitats and create new hotspots? Will they mutate and develop into more pathogenic infections?"

Parasitic worms, specifically soil-transmitted helminths, are common and infect roughly 25% of the global human population, according to the World Health Organization. They're also a major source of infection in animals, causing large economic loss to the livestock industry. Yet, Cattadori said, studies on climate and infections typically look at diseases carried by vectors like mosquitoes and ticks.

"There isn't much attention on helminth infections because they're not as threatening as vector-borne diseases, and people tend to underestimate the importance of worm infections," Cattadori said, further explaining that most studies focus on temperature, and few consider other climate-related variables, like humidity, as drivers of infection.

The lifecycle of soil-transmitted helminths has two phases—a free-living stage as eggs and larvae in the environment and an adult stage inside the host. Researchers sought to understand how the free-living stages were affected by climate.

They reviewed current scientific literature to gather data on the effect of temperature and relative humidity on helminth egg and larval stages of nine species of helminth that commonly infect livestock and wildlife. These species were then divided into two groups depending on where they reside in their host: worms that live in the stomach and worms that live in the intestines.

Based on this information, they developed a mathematical model to describe how helminth hatching, development and mortality of each helminth group respond to temperature and humidity. They then applied this model to look at historical and future projections of infection risk under different climate change scenarios across Southern, Central and Northern Europe. For future projections, they considered short-term, from 2041 to 2060, and long-term, from 2081 to 2100, scenarios.

"We didn't just look at correlation or linear relationships between variables. We disentangled how each component of the free-living stages is affected by climatic conditions, developing a mechanistic understanding of how helminths respond to these environmental stressors," said Chiara Vanalli, postdoctoral scholar at Penn State and lead author of the study, which she conducted as a graduate student in Cattadori's lab. "This is essential for understanding what might happen in the future."

The study is one of the first, Cattadori said, to look at the interaction between multiple climate variables across multiple parasitic worm species to understand how these factors may alter the seasonal profile of disease transmission, as well as when and where these patterns might arise.

Researchers discovered that not all parasite species behave the same way. Those that reside in the host's intestines were strongly affected by temperature, reaching the highest risk of infection at 50 degrees Fahrenheit. On the other hand, helminths that reside in the stomach responded strongly to humidity, reaching their peak when humidity was 80% or higher.

When researchers looked at the seasonality in these patterns across Europe, they found that historically, infection risk has one or two peaks in the spring and summer for the intestinal group and one peak for the stomach group. However, in the future, they expect these peaks may change.

"The intensity of these peaks and the way they shift will depend on location and specific climatic conditions as well as helminth species type," Vanalli said. A two-season trend, with one peak in spring and one in fall, is expected to intensify for intestinal helminths while stomach helminths may be more likely to maintain the summer peak, especially at northern regions.

Researchers also considered how spatial distribution may change too. Historically, infection risk is low in Northern Europe. However, when researchers looked into the future, they found that infection hot spots will shift north, facilitated by increasingly milder climate in central and northern regions while southern regions will undergo more extreme temperature and drier conditions.

Over the long term, Scandinavian countries are projected to experience the greatest risk among both groups of helminths, up to an increase of 100% for the intestinal species and 55% for the stomach species compared to the rest of the continent. What's more, the drastic increase in infection risk at mid-to-high latitudes may likely intensify the risk of co-infection since multiple species of helminths could thrive together.

With a better understanding of how animals are exposed to these infections and potential changes in the future, the findings could lead to the development of better livestock management and preventative control strategies, the researchers said. The dynamics described by the researchers could also shed light on the potential risk for human health because some of the family groups studied include parasites that also affect humans.

"We need to start thinking about how to adapt our strategies to a world where climate is changing," Cattadori said.

More information: Chiara Vanalli et al, Helminth ecological requirements shape the impact of climate change on the hazard of infection, *Ecology Letters* (2024). DOI: 10.1111/ele.14386

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