Researchers connect declining atmospheric sulfur dioxide levels to rise in Legionnaires' disease

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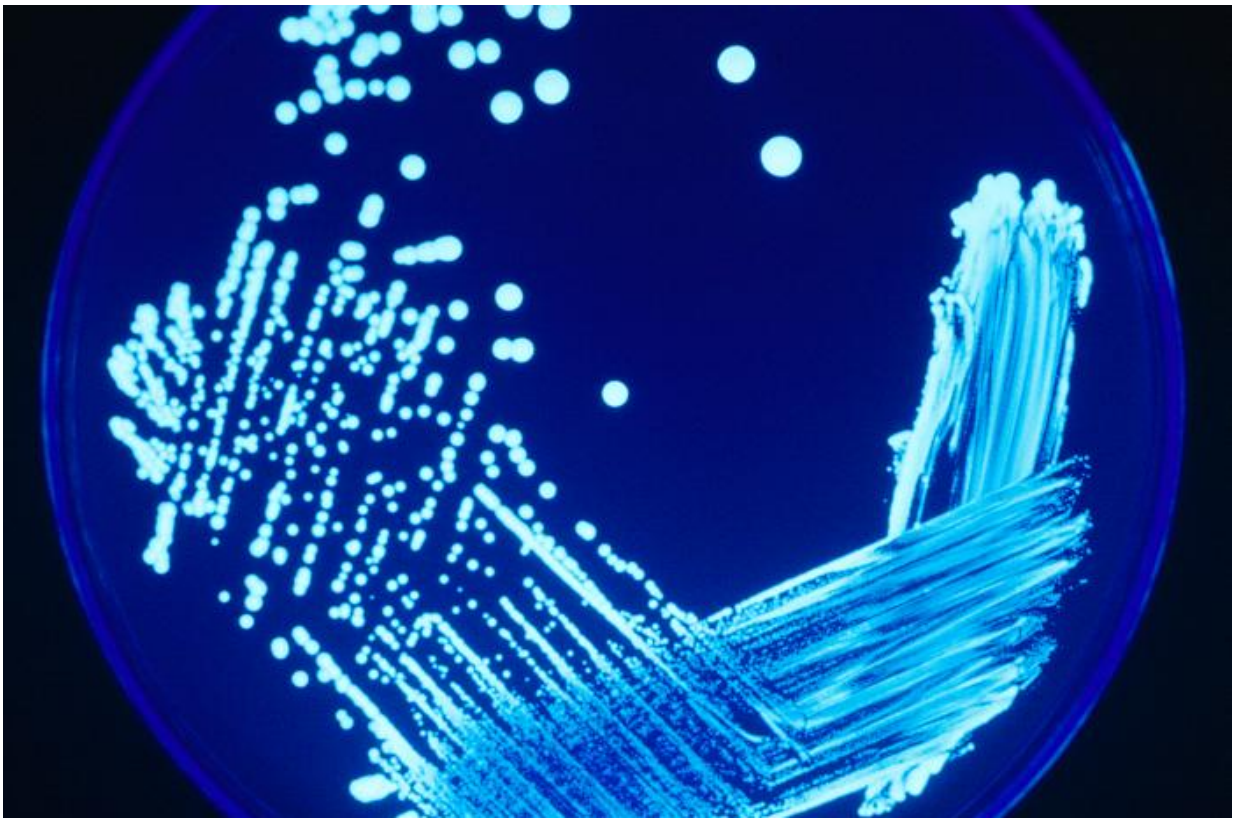

Legionella sp. colonies growing on an agar plate and illuminated using ultraviolet light to increase contrast. Obtained from the CDC Public Health Image Library. Credit: CDC/James Gathany (PHIL #: 7925)

Declining atmospheric sulfur dioxide levels might be related to the global rise in Legionnaires' disease—a severe form of pneumonia caused by inhaling the pathogenic bacteria Legionella. So reports a new University at Albany study, published today in the journal *PNAS Nexus*, which examined trends in atmospheric sulfur dioxide, Legionnaires' disease incidence, and the role of cooling towers in harboring Legionella.

Sources of Legionella—which can multiply in building water systems and spread through the air—are well known, as are seasonal trends that affect the bacteria as a public health risk. Yet, the global increase in cases has been a puzzle.

According to the U.S. Centers for Disease Control and Prevention (CDC), from 2000 to 2018, Legionnaires' disease cases have seen a nine-fold increase nationally, with New York State carrying the highest disease burden and having the fastest increase in the country.

"Atmospheric acidity influences the survival time of Legionella," said co-lead author Fangqun Yu, senior research faculty at UAlbany's Atmospheric Sciences Research Center. "This is true of Legionella found in contaminated droplets from cooling towers and other sources such as hot tubs and decorative fountains. Here, we examined the transmission pathway of Legionella into the air. Understanding how changing environmental conditions influence Legionella proliferation is critical to mitigating this important public health risk."

Environmental impact on Legionella bacteria and disease risk

Legionella are highly sensitive to acidity and perish quickly in low-pH conditions. Over the past half-century, thanks to legislation designed to cut sulfur dioxide emissions, pH levels in the atmosphere have increased, with major benefits for human and environmental health. With less sulfur dioxide in the atmosphere, however, water droplets emitted from cooling towers and other water systems are less acidic, making it easier for resident Legionella to survive, become airborne and remain viable as they spread.

The UAlbany researchers focused on cooling towers—water handling systems associated with industrial, commercial and large residential HVAC systems. Among the many places Legionella flourish (e.g., hot water tanks, showerheads, sink faucets), cooling towers are a leading concern because they can emit plumes of airborne bacteria, which, when conditions are right, can drift and infect people as far as 10km away.

Using data on Legionnaires' disease incidence from the CDC, the team analyzed case numbers and locations across the country. Environmental conditions including atmospheric sulfur dioxide, temperature, precipitation, relative humidity and UV index were factored into the analysis. They found Northeastern states had the highest disease burden, with New York at the top of the list.

Narrowing in on New York, the team examined the effects of atmospheric sulfur dioxide and cooling towers on Legionnaires' disease case numbers. From 1992 to 2019, cases rose at a rate similar to that of sulfur dioxide concentration decrease. With geotagged data from the New York State registered cooling tower database, the team mapped case numbers against cooling tower locations, and found trends linking cooling tower proximity and disease incidence.

"Legionella bacteria can be dispersed through aerosols over considerable distances, which vary with prevailing environmental conditions like

humidity, temperature, wind speed and direction," said co-lead author Arshad A. Nair, postdoctoral associate at UAlbany's Atmospheric Sciences Research Center. "The risk of hospitalization for Legionnaires' disease increases with proximity to a cooling tower. Here, we demonstrate that the average range of elevated risk extends to 7.3 km from a cooling tower; this range has been increasing over the last two decades."

Informing public health strategy

The team's findings are especially important for protecting vulnerable populations that disproportionately experience conditions that increase Legionnaires' disease risk such as living near industrial or densely populated areas or having preexisting health conditions.

"While there are many documented reports linking cooling towers to larger Legionnaires' disease outbreaks, this study helps explain the many 'sporadic' cases," said Ursula Lauper, clinical assistant professor in the Department of Environmental Health Sciences at UAlbany's School of Public Health and Section Chief of Water Systems Control and Analysis at the NYS Department of Health. "It's important that cooling towers be regularly monitored, tested and cleaned. NYS regulation requires that cooling towers be sampled for Legionella every 90 days while in use.

"Because we know that there are different incidence rates of Legionnaires' disease around the state, we're using findings from this study to develop prevention and awareness strategies. We continue to work closely with our regional offices and local health department partners to enforce the state's cooling tower regulations and to investigate clusters while also working on the bigger-picture questions like atmospheric effects."

"The reason why Legionnaires' has been increasing since 2000 could be

explained by multiple complex changes which we plan to examine deeper in future studies," said Shao Lin, professor and chair of UAlbany's Department of Environmental Health Sciences at the School of Public Health. "Ongoing emission reduction policies have significantly reduced air pollution levels and cardio-respiratory diseases burdens in NYS. This new research aims to clarify one of many factors that shape respiratory disease risk."

Protecting people and the environment

Despite the new findings, reducing pollution and atmospheric acidity is unquestionably good for people and the environment. Yu likened the team's findings to understanding the side effects of a lifesaving medication.

"In this case, the 'side effects' are expected to be much smaller than the well-recognized health benefits of reduced air pollution," said Yu. "Our study is an attempt to identify such side effects, which can help inform strategies to mitigate them while maintaining air quality and its many benefits.

"This work showcases an important collaboration between the academic community and state agencies to address an emerging real-world environmental issue. This sort of collaboration is especially critical as air quality and environmental conditions may have complex associations with other diseases (including cardiovascular and respiratory diseases, neurological disorders, and perinatal complications), especially with changing climate and atmospheric chemical compositions."

"Further research is needed to craft specific policy recommendations for addressing this issue," said Lin. "Next, our team will collaborate with NYSDOH to delve deeper, including controlling for potential confounders like co-pollutants, environmental and genetic factors, and

meteorological conditions associated with climate change. We will also use AI methods to develop a predictive model of Legionella including natural, built and social factors."

More information: Fangqun Yu et al, Mysteriously rapid rise in Legionnaires' disease incidence correlates with declining atmospheric sulfur dioxide, *PNAS Nexus* (2024). DOI: 10.1093/pnasnexus/pgae085

Provided by University at Albany