

Research presents new information about the Flint water crisis

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Based on a detailed statistical analysis of multiple datasets, the Flint Area Community Health and Environment Partnership (FACHEP) research team found that the majority of Legionnaires' disease cases that

occurred during the 2014-15 outbreak in Genesee County, Michigan, can be attributed to the change in of the City of Flint's drinking water supply to the Flint River. The researchers also found that the specific strain of *Legionella* isolated from Flint residences as part of FACHEP's sampling in 2016 is not readily detected by common diagnostic tests for *Legionella*. These conclusions are part of two peer-reviewed scientific reports authored by FACHEP and recently published in the academic journals *Proceedings of the National Academy of Science (PNAS)* and *mBio*.

The researchers conducted an exhaustive analysis of data on Legionnaires' cases in Genesee, Wayne and Oakland Counties from 2011 to 2016. FACHEP researchers determined that in 2014-15 there was an increase in the risk of acquiring Legionnaires' disease across the Flint water distribution system that is consistent with a systemwide proliferation of *Legionella* bacteria. An estimated 80 percent of Legionnaires' cases during this period are attributable to the change in water supply, according to the article in PNAS.

"During the period when their water was supplied from the Flint River, Flint residents were seven times more likely to develop Legionnaires' disease," said lead author Sammy Zahran, professor of economics at Colorado State University. "After public announcements urging residents to boil their water, there was a lower risk of developing the disease, likely because people avoided using their water."

Data indicate that the Legionnaires' outbreak at a local hospital alone could not account for the increase in Legionnaires' disease cases that occurred in Flint during the water crisis.

"Our study shows that during the water crisis, the risk of a Flint resident having Legionnaires' disease increased as the amount of free chlorine in their water decreased," said Shawn McElmurry, associate professor of

civil and environmental engineering at Wayne State University and the FACHEP principal investigator. "Since municipalities typically evaluate the risk of waterborne illnesses by measuring free chlorine, a better understanding of how chlorine is deactivated can inform future water management policies and practices."

Chlorine is a chemical that is routinely added to drinking water to kill microbes.

During the water crisis, the likelihood of Legionnaires' disease occurring in communities adjacent to Flint also increased, probably due to the number of people who commuted into Flint.

The analysis also suggested that chlorine residual levels recommended by regulatory agencies (0.2 or 0.5 parts per million) may not be sufficient to protect communities from *Legionella pneumophila* exposure when water quality conditions are such that they support strong *Legionella pneumophila* growth. These were the conditions in Flint during and immediately after the water change.

After the city returned to the Lake Huron water source supplied by the Great Lakes Water Authority, the risk of a Flint neighborhood presenting with Legionnaires' disease retreated to historically normal levels.

From a random sampling of water from approximately 130 Flint households in fall 2016, after return to the Lake Huron water source, *Legionella* bacteria were isolated from 12 percent of homes surveyed. This frequency was similar to findings from residences in neighboring areas.

While Legionnaires' disease is typically associated with *Legionella pneumophila* strains classified as "serogroup 1," the majority (16 out of

18) of strains isolated from Flint residences were closely related serogroup 6 *Legionella pneumophila* strains, according to the article published in *mBio*. In the United States and Europe, more than 90 percent of Legionnaires' disease cases are diagnosed using a urine test that readily detects serogroup 1, but not serogroup 6 or other serogroups of *Legionella* bacteria.

"In laboratory tests of disease risk, the serogroup 6 strain isolated from Flint and Detroit homes resembled the serogroup 1 bacteria obtained from Legionnaires' disease patients in Southeast Michigan," said Michele Swanson, professor of microbiology and immunology at the University of Michigan Medical School and senior author of the *mBio* article. The strains obtained from Flint and Detroit residences are similar to bacteria isolated from Legionnaires' disease patients in other countries, as judged by their genetic fingerprint.

One *Legionella pneumophila* strain isolated from a Flint residence is genetically similar to the serogroup 1 bacteria obtained from Legionnaires' disease patients in Southeast Michigan. Whether this small group of patients became ill after inhaling contaminated water in a Flint home can be assessed by more detailed analysis.

The study did not determine whether serogroup 6 *Legionella pneumophila* contributed to pneumonia of unknown origin in Southeast Michigan. Other studies have found that serogroup 6 can cause Legionnaires' disease.

Swanson said that more research is needed. "To evaluate risk, we need to know whether serogroup 6 *Legionella pneumophila* survive as well as serogroup 1 bacteria do in water aerosols, since that's how people inhale this bacterium," she said. "Whether the treated Flint River water altered the virulence or resilience of *Legionella pneumophila* is another key question we need to examine."

McElmurry noted that the investigation was challenging. "These are very complicated questions, and we are working with a very talented team of investigators including epidemiologists, infectious [disease](#) specialists, microbiologists, water engineers, social-behavioral scientists and statisticians to understand what happened in Flint," he said. "Most important was the assistance of residents who worked directly with us on this challenging problem."

The peer review process for research published in academic journals helps verify that the methods and conclusions have been evaluated by experts in the field and meets rigorous standards for accuracy. Research and the peer review process take time. "While we have been anxious to share these results as soon as possible we thought it was also important that our research was subjected to the highest level of independent review," said McElmurry. "Peer review allows us to demonstrate that our work is independent and free of any external influence."

Dr. Lawrence Reynolds, a Flint area pediatrician and member of Governor Snyder's Flint Water Advisory Task Force and the Flint Water Interagency Coordinating Committee, noted that the FACHEP group engaged the community in its research efforts.

"This abandonment of basic human and civil rights by those who once had the public trust led to water quality, safety and access issues that endangered the public health. In the midst of this maelstrom, a group of engineers along with medical, public health and social scientists assembled a research team to pursue answers to problems that others would rather leave unexamined. The authors of these papers from several universities and members of the research team - which included community members in meaningful roles - affirmed the higher purpose of science - to expand knowledge and serve the common good. As this FACHEP team developed, the key underpinning was the attention to clear, honest communication and careful listening to disenfranchised,

marginalized Flint residents."

FACHEP is a consortium led by Wayne State University that includes the University of Michigan, Michigan State University, Kettering University, Colorado State University and the Henry Ford Health System.

The FACHEP team collected water samples from 357 randomly selected homes in Flint including 136 homes in 2016 and 221 homes in 2017. It also collected samples from 268 randomly selected homes in Genesee County, including 51 homes tested in 2016 and 217 homes tested in 2017, and 141 randomly selected homes in Wayne County.

Samples collected in Genesee County, outside of Flint, and in Wayne County will serve as comparisons to Flint samples to better understand [water](#) quality in Flint.

More information: Sammy Zahran et al., "Assessment of the Legionnaires' disease outbreak in Flint, Michigan," *PNAS* (2018). www.pnas.org/cgi/doi/10.1073/pnas.1718679115

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