Dry winters linked to seasonal outbreaks of influenza

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The seasonal increase of influenza has long baffled scientists, but a new study published this week in *PLoS Biology* has found that seasonal changes of absolute humidity are the apparent underlying cause of these wintertime peaks. The study also found that the onset of outbreaks might be encouraged by anomalously dry weather conditions, at least in temperate regions.

Scientists have long suspected a link between humidity and seasonal (epidemic) flu outbreaks, but most of the research has focused on relative humidity - the ratio of water vapor content in the air to the saturating level, which varies with temperature. Absolute humidity quantifies the actual amount of water in the air, irrespective of temperature. Though somewhat counter-intuitive, absolute humidity is much higher in the summer. "In some areas of the country, a typical summer day can have four times as much water vapor as a typical winter day - a difference that exists both indoors and outdoors," said Jeffrey Shaman, an Oregon State University atmospheric scientist and lead author.

The researchers used 31 years of observed absolute humidity conditions to drive a mathematical model of influenza and found that the model simulations reproduced the observed seasonal cycle of influenza throughout the United States. They first examined influenza in New York, Washington, Illinois, Arizona and Florida, and found that the absolute humidity conditions in those states all produced model-simulated seasonal outbreaks of influenza that correlated well with the observed seasonal cycle of influenza within each state. Shaman and colleagues then extended their model to the rest of the continental U.S. and were able to reproduce the seasonal cycle of influenza elsewhere. They also discovered that the start of many influenza outbreaks during the winter was directly preceded by a period of weather that was drier than usual.

"This dry period is not a requirement for triggering an influenza outbreak, but it was present in 55 to 60 percent of the outbreaks we analyzed so it appears to increase the likelihood of an outbreak," said Shaman. "The virus response is almost immediate; transmission and survival rates increase and about 10 days later, the observed influenza mortality rates follow."

Though the findings by Shaman and his colleagues build a strong case for absolute humidity's role in influenza outbreaks, it does not mean you can predict where influenza will strike next. As Shaman emphasized, "Certainly absolute humidity may affect the survival of the influenza virus, but the severity of outbreaks is also dependent upon other variables, including the type of virus and its virulence, as well as host-mediated factors such as the susceptibility of a population and rates of population mixing and person-to-person interactions."

Marc Lipsitch, a professor of epidemiology at the Harvard School of Public Health and senior author on the new study, said the new analysis may have implications for other diseases. "Seasonality of infectious diseases is one of the oldest observations in human health, but the mechanisms - especially for respiratory diseases like flu - have been unclear," Lipsitch said. "This study, in combination with Shaman and (Melvin) Kohn's earlier analysis of laboratory experiments on flu transmission, points to variation in humidity as a major cause of seasonal cycles in flu."

"Seasonal variation in flu, in turn, helps to explain variation in other infectious diseases - such as pneumococcal and meningococcal disease - as well as seasonal variation in heart attacks, strokes and other important health outcomes."

Lipsitch directs the Center for Communicable Disease Dynamics, of which Shaman is a member. This study and the center are supported by the

Models of Infectious Disease Agent Study, or "MIDAS Program," of the U.S. National Institute of General Medical Sciences.

"The discovery of a link between influenza outbreaks and absolute humidity could have a major impact on the development of strategies for limiting the spread of infection," said Irene Eckstrand, who oversees the MIDAS program. "Understanding why outbreaks arise is an important first step toward containing or even preventing them, so it is essential for scientists to follow up on this intriguing connection."

More information: Shaman J, Pitzer VE, Viboud C, Grenfell BT, Lipsitch M (2010) Absolute Humidity and the Seasonal Onset of Influenza in the Continental United States. PLoS Biol 8(2): e1000316. doi:10.1371/journal.pbio.1000316

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