

Interdisciplinary study reveals health care costs of extreme heat

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A new report produced by an interdisciplinary group of faculty, staff and students at Virginia Commonwealth University and published by the

Center for American Progress is shedding light on the connections between rising heat and harm to health. The report, titled "[The Health Care Costs of Extreme Heat](#)," sets the stage to discuss heat's impact by recalling recent heat events that have collectively harmed and hospitalized thousands of people.

The researchers used available data in Virginia to estimate the increase in [health care utilization](#) associated with extreme [heat](#), such as emergency department visits, hospital admissions and the [health](#) care costs those services generated. Daily climate data collected from 15 [weather stations](#) serving Virginia showed that an average of 80 heat event days occurred per summer from 2016 to 2020. Based on insurance claims data from Virginia's All-Payer Claims (APC) database, the researchers calculated that heat events each summer result in:

- Almost 400 additional ambulatory care visits for heat-related illness.
- Almost 7,000 additional emergency department visits, including more than 4,600 visits for heat-related or heat-adjacent illness.
- Almost 2,000 extra heat-related hospital admissions, mostly for heat-adjacent illness.

Extrapolated nationally, the researchers found that heat event days would be responsible for almost 235,000 emergency department visits and more than 56,000 hospital admissions for heat-related or heat-adjacent illness, adding approximately \$1 billion in costs every summer.

"One of the key goals of this report is to help the public understand the implications of extreme heat on health," said Steven Woolf, M.D., a professor in the Department of Family Medicine and Population Health at the VCU School of Medicine and one of the co-authors of the report. "Unless we take action to mitigate the effects of climate change, heat events are projected to keep increasing in frequency, resulting in an even

greater blow to public health."

Woolf is a senior fellow at the Center for American Progress and director emeritus of the VCU Center on Society and Health.

Heat takes a toll

Hot summer days have always posed a risk of health complications, but climate change is causing an increase in prolonged periods of extreme heat.

"The U.S. Environmental Protection Agency has been monitoring long-term weather patterns in the United States, and every decade since the 1960s has seen an increase in both the frequency and duration of heat waves," said Stephen Fong, Ph.D., director of the VCU Integrative Life Sciences doctoral program and a professor in the Department of Chemical and Life Science Engineering at the VCU College of Engineering, who co-authored the report. "While the situation now is not great, effects of heat are projected to continue to worsen."

The harmful health effects of extreme heat include heat-related illness due to dehydration as well as heat exhaustion and heat stroke. Extreme heat also affects people with heart disease, pulmonary disease and other chronic problems, whose health can further deteriorate when exposed to hot conditions. Those people often get seen in an outpatient setting or the emergency department, and if they are sick enough, they will be admitted to the hospital.

"Such health care visits were our outcome measures, to see how the increasing occurrence of extreme heat events takes a toll on our collective health and on the health care system," Woolf said. "We then applied federal data on the average cost of emergency room visits and hospitalizations to estimate a total cost to the nation of about \$1 billion

per year associated with extreme heat."

"There are environmental, personal and community factors that either build resiliency or put people in communities at risk," said Alex Krist, M.D., a professor in the VCU School of Medicine's Department of Family Medicine and Population Health and a co-author of the report. "Understanding these factors can inform how we approach health care, the environment and policy."

The report's authors recommend that leaders deal with the root cause of the problem, which is climate change itself, by prioritizing limits on greenhouse gas emissions. The authors also suggest that leaders work to make communities more resilient to extreme heat. This includes making changes to their infrastructure and implementing initiatives that limit exposure to extreme heat, such as planting trees and expanding green space, designing buildings to absorb less heat, and increasing shade.

The study was made possible by harnessing the skills and expertise of researchers from various VCU schools and academic centers. Krist said the interdisciplinary effort is exciting because it brought together researchers from different fields to better understand one of the biggest issues facing society today.

"Our environmental sciences colleagues have expertise in instruments that collect data on heat events or tell us about the fine particulate matter polluting our atmosphere," Krist said. "At the School of Medicine, we know about the health effects of heat, air quality and water quality. We also have access to data like the Virginia APC database to be able to understand how health care delivery and health outcomes are impacted by [environmental factors](#). We combined these two worlds to be able to create this data and analysis."

"The collaborative nature of the VCU team was remarkable, as

researchers came from different fields and discussions ranged from details of raw data to conceptual goals and policy recommendations," Fong added. "It helped that we all understood the significance of this problem and the need to do a rigorous analysis that can help increase awareness."

Research methods

Greg Garman, Ph.D., an environmental scientist and director at the VCU Rice Rivers Center and one of the principal investigators, said one of the challenges the group faced was figuring out how to integrate the very different types of data used by health professionals versus environmental scientists. For example, data on respiratory health outcomes are collected at very different temporal and spatial scales, and with different methods and assumptions, than data on atmospheric ozone concentrations.

"These different data sets must be integrated in order to confidently answer complicated but important questions about the possible impacts of ground-level ozone on the incidence of asthma in underserved urban communities during summer months," Garman said. "An early success of our Breakthroughs collaboration, resulting in this [extreme heat](#) analysis, was the integration of public health and atmospheric science data by a consortium of research-trained M.D.s and Ph.D.s at VCU."

Garman sees the report as a compelling example of the important work that a large research university can accomplish when disciplinary silos are eliminated and scholars from units as diverse as medicine, engineering and environmental science collaborate in the same intellectual space.

The research team noted that all participants were learners in the collaboration.

"We've combined these unique robust data sets that can allow us to ask whole sets of questions that we couldn't answer before," Krist said. "This incremental analysis of health events due to an environmental exposure is not something that we've really done before. We're now applying this approach to a range of topics, like exposure to poor air quality and its impact on asthma and chronic obstructive pulmonary disease events. This collaboration has set us up to be able to do a whole new set of research."

The researchers credit Funk with doing the heavy lifting in terms of statistics, integrating the different data sets, performing the needed calculations and visualizing how spikes in heat events related to spikes in [health care](#) visits.

"Whether it's this heat, air or water analysis, we have these up-and-coming ideas that are novel from everything I've seen," Funk said. "It's really cool to be able to gather all these pieces, put them together like a puzzle and see a picture we've never seen before. We're learning so much from each other and with each other at the same time."

The research team is now working to publish the report in a scientific journal, with plans to determine which communities are the most impacted by heat events.

Provided by Virginia Commonwealth University

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