

Forecasting COVID-19 Transmission Across Time in U.S. Counties

Statement of Problem

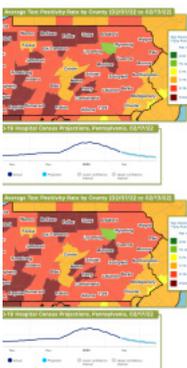
As the nation responded to the generational challenge of the COVID-19 pandemic, forecasting viral transmission across local communities became an important tool for planning and response. In the initial phase of the pandemic, this information was critical to help local, state and federal leadership make informed decisions about public policy solutions to manage the crisis.

Following the first wave of the pandemic in March 2020, there was a need to expand on robust and reliable data models that were increasingly relevant to local communities to inform their safe reopening. Together with reviewing emerging data on school and community safety, these data also helped communities navigate decision-making regarding returning more children to in-school instruction.

With available vaccines and regional variability in community transmission rates, COVID-19 is now transitioning toward an endemic virus with seasonal peaks in transmission; even so, we would anticipate additional periods of resurgence ahead, and it will be crucial to provide scientific evidence to support speedy and accurate responses.

Description

COVID-Lab: Forecasting COVID-19 Transmission Across Time in U.S. Counties



Through their COVID-Lab model, our interdisciplinary team across Children's Hospital of Philadelphia and the University of Pennsylvania offered county-level data on test positivity and case counts from April 2020 to April 2022.

Through this project, our interdisciplinary team from Children’s Hospital of Philadelphia (CHOP) and the University of Pennsylvania has used county-level data to longitudinally track COVID-19 transmission and test positivity rates across all U.S. counties. Between April 2020 and May 2021, and again from September 2021 to February 2022, the models provided four-week projections of case transmission for as many as 821 counties with active outbreaks, representing 82% of the U.S. population and 83% of all identified coronavirus cases, and offered four-week state-level forecasts for hospital admissions and census. The 821 counties included those with state capitals, populations of 40,000 individuals or more (with a minimum population density of 250 people per square mile), and sustained outbreaks, which are defined further in [this abstract](#).

Through these models, the team accounted for the impact of weather, health, demographics, county-level vaccination rates, and other local area effects of the population and city characteristics to develop forecasts that were calibrated to the actual rate of growth in county transmission during the prior week. The models considered over time the influence of temperature and humidity on SARS-CoV-2 transmission; determined the impact of social distancing in modifying the trajectory of SARS-CoV-2 transmission during current and future outbreaks; and parsed how city characteristics modified the risk of transmission.

The result was a highly dynamic model, rooted in the influence of environmental and behavioral factors on transmission, which could examine the effects of policy change and social distancing practices on the risk for virus resurgence. To guide community recommendations, the team also incorporated other key data into the models to permit more comprehensive assessments of local-area risk for COVID-19 transmission. Our dashboards offered visualizations that display a national map highlighting state-level COVID-19 intensive care unit occupancy, hospital daily census, new daily COVID-19 admissions and daily COVID-19 emergency department visits.

While the dashboards are no longer active, the team continues to use a variety of data sources to evaluate and validate their methodology and software for pandemic forecasting, real-time monitoring, mitigation, and prevention of the spread of pathogens, aiming to expand the applicability of the methods behind COVID-Lab to modeling the transmission of other infectious diseases. They are also training early career scientists in modeling transmission of pathogens in health care settings.

The data and methodology behind this modeling project was informed by a peer-reviewed study, published in [JAMA Network Open](#), revealing social distancing to be the strongest mitigating factor in reducing COVID-19 transmission. Additionally, the team’s modeling efforts helped to inform a [Health Affairs study](#), which found that county-level mask mandates reduced case incidence early in the pandemic, even if that effect waned over time.

The team utilized its modeling data to advise the White House Coronavirus Task Force, governors, state public health officials, and community leaders on emerging hotspots and local strategies for reducing the spread of the virus. Furthermore, the model has helped inform [school guidance for the 2022-23 academic year](#)—developed in partnership with CHOP’s clinical leadership—to support leaders of K-12 schools and early care and education settings with building their COVID-19 mitigation plans within the context of variable local health department requirements in different communities. **To learn how we validated this model to ensure accurate projections, click [here](#), and to learn more about the methods of this model, see [this abstract](#).**

Next Steps

As mentioned above, we will continue to monitor community transmission and may provide updates from time to time through PolicyLab’s social media channels and blog to help guide the public should conditions change. The team is also working on additional peer-reviewed articles based on this project and continues to mentor early career scientists in utilizing their modeling methods.

For more on PolicyLab's COVID-19 response and guidance to assist schools and communities with reopening strategies, click [here](#).

This project page was last updated in October 2022.

Suggested Citation

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PolicyLab Leads

Jing Huang PhD

Associate Director of Observational Research

Jing Huang (she/her) is the associate director of observational research at PolicyLab at Children's Hospital of Philadelphia (CHOP), an assistant professor of biostatistics in the Department of Biostatistics, Epidemiology, and Informatics at the University of Pennsylvania's Perelman School of Medicine, and a senior scholar in the Center for Clinical Epidemiology and Biostatistics at the University of Pennsylvania's Perelman School of Medicine.

Dr. Huang's research focuses on the development of advanced statistical and computational methods for analyzing longitudinal health data to inform health decision-making and disease control policies. Her foundational work in statistical inference has driven the creation of methodologies for analyzing longitudinal and time-series data, addressing real-world challenges in health care and public health. She specializes in interpreting large health care datasets, including electronic health records (EHRs) and claims data, and integrating evidence from multiple databases to advance big data analytics and precision medicine.

Dr. Huang has contributed to key areas such as predictive modeling, trajectory analysis and causal inference. She co-founded the "COVID-Lab: Mapping COVID-19 in Your Community" forecasting model at PolicyLab, which provided county-level predictions of COVID-19 transmission and was used by federal, state, and local authorities for critical pandemic decision-making. This initiative reflects her dedication to developing actionable models that support real-time public health efforts.

As the principal investigator on multiple NIH, CDC and PCORI-funded projects, Dr. Huang has demonstrated a strong track record of leading interdisciplinary collaborations across infectious diseases, health policy and data science. She is committed to advancing innovative and practical solutions that address pressing issues in health care and public health.



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Brian Fisher **DO, MPH, MSCE**

Faculty Scholar

Brian Fisher is a faculty scholar at PolicyLab, core faculty member of the [Pediatric Infectious Diseases Epidemiology and Antimicrobial Stewardship \(IDEAS\)](#) research group at Clinical Futures at Children's Hospital of Philadelphia (CHOP). Dr. Fisher's research focuses on infections in children with immunocompromising conditions. He is particularly interested in infections in children with cancer and serves as the chair of the Infectious Disease Subcommittee within the Children's Oncology Group. This subcommittee designs and oversees all infectious disease clinical trials performed within COG. He also serves as the co-director of the International Pediatric Fungal Network, a consortium dedicated to improving outcomes of invasive fungal disease in children through improved diagnostic and therapeutic approaches.

Additionally, Dr. Fisher is one of the investigators working on PolicyLab's COVID-19 forecasting model, known as "[COVID-Lab: Mapping COVID-19 In Your Community](#)," which tracks coronavirus transmission and test positivity rates across all U.S. counties, and projects cases counts for more than 800 counties with active outbreaks. Dr. Fisher and his collaborators have received national attention for this unique project, which they have used to advise the White House Coronavirus Task Force, governors, state public health officials and Philadelphia leaders on emerging hotspots and local strategies for reducing the spread of the virus.

Dr. Fisher is an associate professor of pediatrics and epidemiology at the Perelman School of Medicine at the University of Pennsylvania, a senior scholar in the [Center for Clinical Epidemiology and Biostatistics](#) at the University of Pennsylvania, and an attending physician in the [Division of Infectious Diseases](#) at CHOP. Dr. Fisher also serves the associate chair for research in the Department of Pediatrics at CHOP.



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Meredith Matone

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Director

Dr. Matone's research interests include maternal and young child health, as well as family well-being. She focuses on building community and public agency research partnerships to support improvements in policies and programs that serve mothers and infants in under-resourced communities. She is experienced in large-scale program evaluation, mixed-methods research designs, and use of administrative data for observational study designs in areas of child and caregiver health.

Dr. Matone is a senior fellow at the University of Pennsylvania's Leonard Davis Institute of Health Economics, a faculty affiliate at The Field Center, and a board member of the Pennsylvania Association for the Education of Youth Children. Dr. Matone received her Doctor of Public Health, specializing in child and adolescent health and development, from Johns Hopkins Bloomberg School of Public Health. She is an alumnus of the Doris Duke Fellowship for the Promotion of Child Well-being program and a former Stoneleigh Foundation fellow.



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Team

Zi Wang

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Biostatistician

Zi Wang is a biostatistician at PolicyLab at Children's Hospital of Philadelphia (CHOP). She has been working at CHOP as a student informatics research assistant in the second semester of her master's degree training at the University of Pennsylvania's Perelman School of Medicine (Penn). Collaborating closely with clinical investigators on a variety of health-related projects, Zi applies a range of advanced statistical techniques in support of scientific research studies and experiments. She also participates in the planning and interpretation of research, consults with scientific investigators, determines statistical analysis strategies, and constructs analysis methodologies. Zi is interested in the field of causal inference in observational studies, infectious disease modeling, measurement error and misclassification, and methods for genetic research of human complex diseases.

Zi has joined PolicyLab to work with our interdisciplinary team from CHOP and Penn, alongside global experts, to project COVID-19 case counts and create forecasting plots across 800+ U.S. counties with active outbreaks. She works closely with Drs. David Rubin and Jing Huang to build and refine forecasting models of local area transmission using real-time data, known as “COVID-Lab: Mapping COVID-19 In Your Community,” which tracks coronavirus transmission and test positivity rates across all U.S. counties to identify emerging hotspots and select local strategies for reducing the spread of the virus.



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Xianqun Luan

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Research Scientist

Xianqun Luan is a research scientist at PolicyLab at Children’s Hospital of Philadelphia (CHOP). His work focuses on data engineering and statistical methods for utilizing medical and billing data in public health policy research, cost-effectiveness analysis, clinical quality improvement and clinical performance.

Xianqun has held several positions at CHOP since 2001, including biostatistician, clinical research data analysis unit technical director and clinical improvement group technical director. He is currently working in an observational research unit with Dr. Jing Huang to cooperate with PolicyLab’s research team. More specifically, he is working within several research areas, including data integration and data engineering, creating algorithms for analysis cohort, statistical methods for the observational study, and time-series analysis. His research goal is to apply practical analysis approaches to assess performance and outcome with accountable data and a valid population.



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Related Tools & Publications

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[How We Validate Our COVID-19 Prediction Models](#)

[Blog Post](#)

Jul 24, 2020

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[COVID-19 Outlook: Lessons Learned from a Year of Modeling the COVID-19 Pandemic](#)

[Blog Post](#)

May 12, 2021

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[COVID-19 Outlook: A Summer Resurgence as Schools Plan for Fall](#)

[Blog Post](#)

Jul 20, 2021

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[COVID-19 Outlook: The Uncertainty of What is to Come](#)

[Blog Post](#)

Aug 05, 2021

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[COVID-19 Outlook: Resurgence is on the Move as Schools Reopen](#)

[Blog Post](#)

Aug 19, 2021

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[COVID-19 Outlook: A Country in Transition](#)

[Blog Post](#)

Aug 26, 2021

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[COVID-19 Outlook: An Especially Challenging Time for Schools](#)

[Blog Post](#)

Sep 02, 2021

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[COVID-19 Outlook: 4 Trends Playing Out Across the Country](#)

[Blog Post](#)

Sep 09, 2021

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[COVID-19 Outlook: Post-Labor Day Impacts Emerge as the South Improves](#)

[Blog Post](#)

Sep 16, 2021

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[COVID-19 Outlook: A Nation Improves, But Challenges Re-emerge in Some Regions](#)

[Blog Post](#)

Sep 24, 2021

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[COVID-19 Outlook: Stabilizing Transmission in Northern Areas Provides New Optimism](#)

[Blog Post](#)

Sep 30, 2021

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[COVID-19 Outlook: We Haven't Yet Turned the Corner in the North](#)

[Blog Post](#)

Oct 08, 2021

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[COVID-19 Outlook: A Fall Resurgence of Uncertain Magnitude Develops as We Await Vaccines for Children](#)

[Blog Post](#)

Oct 14, 2021

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[COVID-19 Outlook: Looking North for Clues as Colder Weather Approaches](#)

[Blog Post](#)

Oct 21, 2021

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[COVID-19 Outlook: Cautious Optimism Before Halloween](#)

[Blog Post](#)

Oct 28, 2021

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[COVID-19 Outlook: Seasonality in the Spotlight as an Inflection Point Arrives](#)

[Blog Post](#)

Nov 04, 2021

- [COVID-19 Outlook: Seasonal Transmission Arrives Before Holiday Season](#)
[Blog Post](#)

Nov 11, 2021

- [COVID-19 Outlook: Transmission Accelerates as Thanksgiving Arrives](#)
[Blog Post](#)

Nov 18, 2021

- [COVID-19 Outlook: Navigating Another Holiday Season of the COVID-19 Pandemic](#)
[Blog Post](#)

Dec 03, 2021

- [COVID-19 Outlook: Preparing for Recovery, Even as U.S. Approaches Peak Seasonal Transmission](#)
[Blog Post](#)

Dec 09, 2021

- [COVID-19 Outlook: Omicron Adds More Uncertainty to Winter COVID-19 Resurgence](#)
[Blog Post](#)

Dec 16, 2021

- [COVID-19 Outlook: A Pandemic in Transition Requires Updated School Guidance](#)
[Blog Post](#)

Jan 05, 2022

- [COVID-19 Outlook: Holiday Peaks Begin to Subside](#)
[Blog Post](#)

Jan 13, 2022

- [COVID-19 Outlook: Recovery Continues, But Some Regions Lag Behind](#)
[Blog Post](#)

Jan 27, 2022

- [COVID-19 Outlook: As Recovery Continues, Schools Plan for Next Steps](#)
[Blog Post](#)

Feb 03, 2022

- [COVID-19 Outlook: Hastened Recovery Continues, Although Some Risk Remains](#)
[Blog Post](#)

Feb 17, 2022

- [COVID-19 Outlook: Tackling Unresolved Questions about Children as Recovery Continues](#)
[Blog Post](#)
Mar 22, 2022

- [COVID-19 Outlook: Forging Forward from the Pandemic](#)
[Blog Post](#)
Apr 22, 2022

- [COVID-19 Outlook: Schools Update Health and Safety Plans For the New Academic Year](#)
[Blog Post](#)
Aug 04, 2022

- [Association of Social Distancing, Population Density, and Temperature With the Instantaneous Reproduction Number of SARS-CoV-2 in Counties Across the United States](#)
[Article](#)
Jul 2020

- [On the Value of COVID-19 Testing for Children Beyond the Spring of 2021](#)
[Article](#)
Apr 2021

- [Association of In-person vs Virtual Education With Community COVID-19 Case Incidence Following School Reopenings in the First Year of the COVID-19 Pandemic](#)
[Article](#)
Apr 2023

Related Projects

[Responding to COVID-19](#)
[Population Health Sciences](#)

[Assisting Childhood Education through Increased Testing](#)
[Population Health Sciences](#)