# Researchers disentangle patterns of indoor mixing for respiratory disease transmission risk

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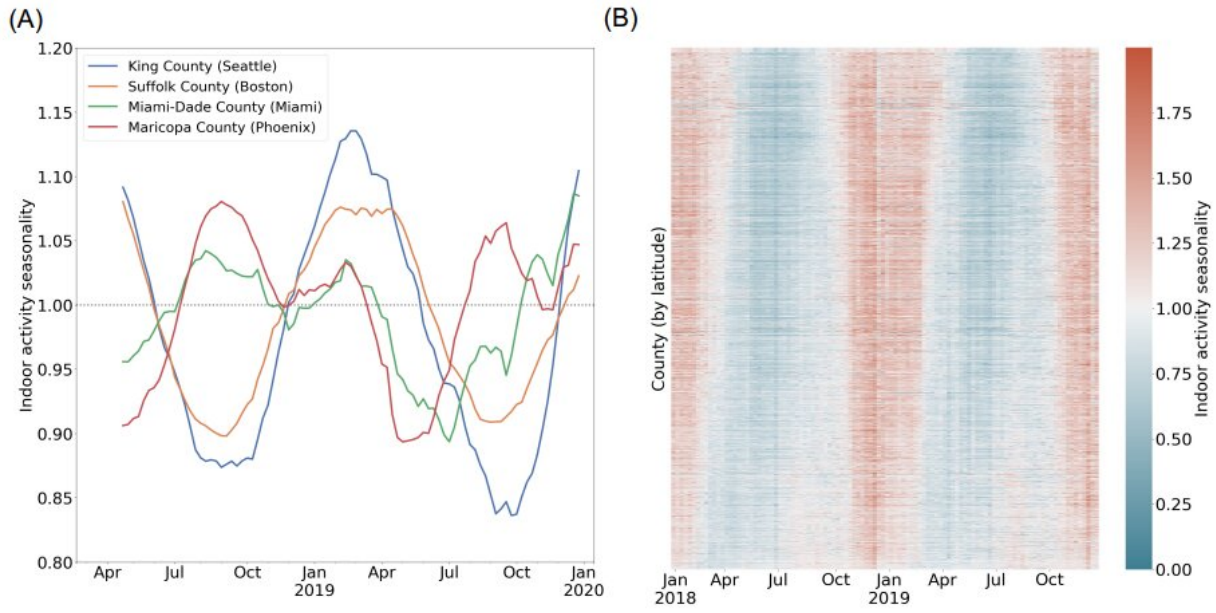


(A) Case studies to highlight varying trends in indoor activity seasonality during 2018 and 2019: King County and Suffolk County (in the northern U.S.) have high indoor activity in the winter months and a trough in indoor activity in the summer months. Miami-Dade and Maricopa County (in the southern U.S.) see moderate indoor activity in the winter and may have an additional peak in indoor activity during the summer. We apply a rolling window mean for visualization purposes. (B) A heatmap of the indoor activity seasonality metric for all U.S. counties by week for 2018 and 2019. Counties are ordered by latitude. We see significant spatiotemporal heterogeneity with distinct trends in the summer versus winter seasons. Credit: *eLife* (2023). DOI: 10.7554/eLife.80466

Researchers have characterized the seasonal effects on human social behavior to provide new insights on the risk of respiratory disease transmission.

Their large-scale analysis, published today in *eLife*, provides a framework of seasonal behavior across the U.S. that could be used in the construction of more evidence-based models of disease transmission.

The impact of the time of year on disease transmission is a familiar and widespread phenomenon, but the processes that cause this seasonality in transmission rates are still largely unclear.

"Models of infectious disease transmission have traditionally used environmental data-driven approaches. However, the seasonality of influenza, COVID-19 and other respiratory pathogens depends on people's social behavior as well as the environment," explains first author Zachary Susswein, who was a Research Associate at senior author Shweta Bansal's lab, Georgetown University, Washington, D.C., U.S., at the time the study was carried out, and is now a Data Analyst at the Rockefeller Foundation, Washington, D.C. "A key gap in understanding the role that social behavior plays in respiratory disease seasonality is our incomplete knowledge of how the time of year impacts indoor mixing among people."

To address this gap, the team used novel data on human mobility to characterize activity in indoor versus outdoor environments in the U.S. The data was taken from the SafeGraph Weekly Patterns dataset, which provides information on foot traffic at public locations, or "points of interest" (POIs), across the U.S. based on the usage of mobile apps with GPS. The data range from 2018–2020 and cover more than five million locations nationally. For their study, the team used 4.6 million POIs

from the dataset over those three years.

From this data, they classified the locations that people visited as primarily "indoor" (for example, stores and offices) or "outdoor" (such as playgrounds and farmers' markets). They then disentangled location-specific visits into indoor and outdoor to construct a novel metric that measures the tendency of people to mix indoors on a weekly scale. They found that the proportion of indoor to outdoor activity during a baseline year (2018 or 2019) is seasonal, peaking in the winter months. The measure shows stronger seasonality of indoor mixing at northern regions and an additional summer peak in southern regions.

Next, the team characterized the shift that occurred in these baseline patterns of seasonal indoor activity during the COVID-19 pandemic. To do this, they compared the mobility patterns they identified in 2018 and 2019 with those during the pandemic in 2020. They found that the pandemic disrupted the patterns identified in the baseline years: in early 2020, when there were substantial social distancing measures across the U.S. (including remote work and school closures), activity was more likely to be outdoors than in previous years.

In four case-study locations—Maricopa County, Arizona; Baltimore County, Maryland; Travis County, Texas; and Charleston County, South Carolina—most saw a shift in their indoor activity patterns from 2018 and 2019, while others (such as Maricopa County) did not. The authors say that the patterns identified in their analysis are necessary for predicting how the dynamics of different diseases might differ across locations and time of year, and how different communities may respond to behavioral interventions.

"Our results suggest that such public health strategies should be implemented in a targeted manner, informed by real-time data and with clear communication of the goals," says author Eva Rest, who was a

Master's Degree student and Global Health Institute fellow at the Bansal Lab, Georgetown University, at the time the study was carried out, and is now an M.D.-Ph.D. student at the Yale School of Medicine, New Haven, Connecticut, U.S.

The authors acknowledge that while novel data streams offer opportunities to address long-unanswered questions, these data must be interpreted carefully. The SafeGraph data, although significant in its size, does not represent the activities of children under 16 years of age due to privacy laws, and may be less representative for elderly individuals due to lower smartphone usage.

"Additionally, our novel metric of indoor mixing may average across the experience of all groups, particularly by socioeconomic status," explains senior author Shweta Bansal, Provost's Distinguished Associate Professor at Georgetown University. Previous research has shown that low-income and racially marginalized communities can have systematically less access to outdoor, natural spaces and can spend more time indoors due to structural inequities such as lack of paid leave. "So, we may very well be underestimating the risk of infection experienced by individuals in these vulnerable communities, and we commit to continued work to better characterize this."

Bansal concludes, "Our current work helps to improve our understanding of the relationship between the indoor environment and infection risk in the context of global change. While the COVID-19 pandemic and climate change may impact indoor activity in different ways, a greater understanding of the seasonality of indoor activity would allow policymakers and emergency preparedness experts to effectively address future disruptions."

**More information:** Zachary Susswein et al, Disentangling the rhythms of human activity in the built environment for airborne transmission

risk: an analysis of large-scale mobility data, *eLife* (2023). DOI: 10.7554/eLife.80466