



## RE: Association Between State-Level Income Inequality and COVID-19 Cases and Mortality in the USA

J Gen Intern Med 36(5):1434  
 DOI: 10.1007/s11606-021-06604-z  
 © Society of General Internal Medicine 2021

Dear Editors,

We read with great interest the article titled “Association Between State-Level Income Inequality and COVID-19 Cases and Mortality in the USA.”<sup>1</sup> We commend the authors for their efforts in exploring the role of income inequality in determining the burden of COVID-19 across different states in the United States (US). Their study may help explain why stark disparities in COVID-19 cases and mortality exist across different population groups and regions. However, we think there are several important limitations in their study that may affect the validity of their findings.

First, the study used multivariable regression to assess associations between the Gini coefficient and COVID-19 cases or mortality, adjusted for confounding variables. The observations are each state. However, linear regression assumes that observations are independent of each other.<sup>2</sup> This may not be the case for state-level data; one can consider, for example, that New York and New Jersey may be much more similar than New York and Hawaii. It would be important to test whether there is spatial autocorrelation between the states prior to making inferences from the model.<sup>3</sup> Failure to account for the spatial autocorrelation could lead to biased effect sizes and inferences.

Second, population density may be an important factor in the spread of COVID-19. The authors have not adjusted for this in their models; we believe this is an important potential confounder. We suggest that the percent of the population living in urban areas, based on the 2010 US Census,<sup>4</sup> could provide a helpful estimate of population density, and that the models should additionally adjust for this covariate.

Third, we are concerned that states may be a large unit of analysis, as there is a great deal of variability within a state. For example, the pandemic trend and income inequality in New York City are largely different from those in upper New York State. Compared to state-level analysis, county-level analysis data could provide more fine-grained findings; income inequality and

COVID-19 cases and mortality are available at the county level, as are most of the covariates.

Lastly, there are limitations to considering cumulative cases. More information may be gained by considering the trajectory of daily reported cases and mortality,<sup>5</sup> as they help us identify trends in how the pandemic naturally develops over time, and assess the shapes of the curve in different states.

Shelley H. Liu, PhD<sup>1</sup>  
 Yan Li, PhD<sup>1,2</sup>  
 Bian Liu, PhD<sup>1,3</sup>

<sup>1</sup>Department of Population Health Science and Policy, Icahn School of Medicine at Mount Sinai, New York, NY, USA

<sup>2</sup>Department of Obstetrics, Gynecology, and Reproductive Science, Icahn School of Medicine at Mount Sinai, New York, NY, USA

<sup>3</sup>Department of Environmental Medicine and Public Health, Icahn School of Medicine at Mount Sinai, New York, NY, USA

**Corresponding Author:** Shelley H. Liu, PhD; Department of Population Health Science and Policy, Icahn School of Medicine at Mount Sinai, New York, NY, USA (e-mail: shelley.liu@mountsinai.org).

**Compliance with Ethical Standards:**

**Conflict of Interest:** No conflicts of interest to declare.

### REFERENCES

1. Oronce CI, Scannell CA, Kawachi I, Tsugawa Y. Association between state-level income inequality and COVID-19 cases and mortality in the USA. *J Gen Intern Med*. 2020;<https://doi.org/10.1007/s11606-11020-05971-11603>.
2. Rosner B. *Fundamentals of Biostatistics*, 7th Ed.; Cengage Learning, Inc.; 2010.
3. LeSage J, Pace K. *Introduction to spatial econometrics*. Boca Raton: CRC Press; 2009.
4. 2010 Census urban and rural classification and urban area criteria. United States Census Bureau; 2019. <https://www.census.gov/programs-surveys/geography/guidance/geo-areas/urban-rural/2010-urban-rural.html>.
5. Liu SH, Liu B, Norbury A, Li Y. Associations between state-level health-care access and COVID-19 case trajectories in the United States. *Medrxiv*. 2020. <https://doi.org/10.1101/2020.1107.1104.20146100>.

**Publisher's Note:** Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Received July 7, 2020  
 Accepted January 5, 2021  
 Published online January 27, 2021