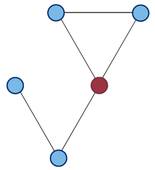

GEORGETOWN UNIVERSITY

Characterizing spatiotemporal trends in self-reported masking behavior in the United States

Juliana C. Taube, Zack Susswein & Shweta Bansal

MIDAS Conference - September 9, 2022

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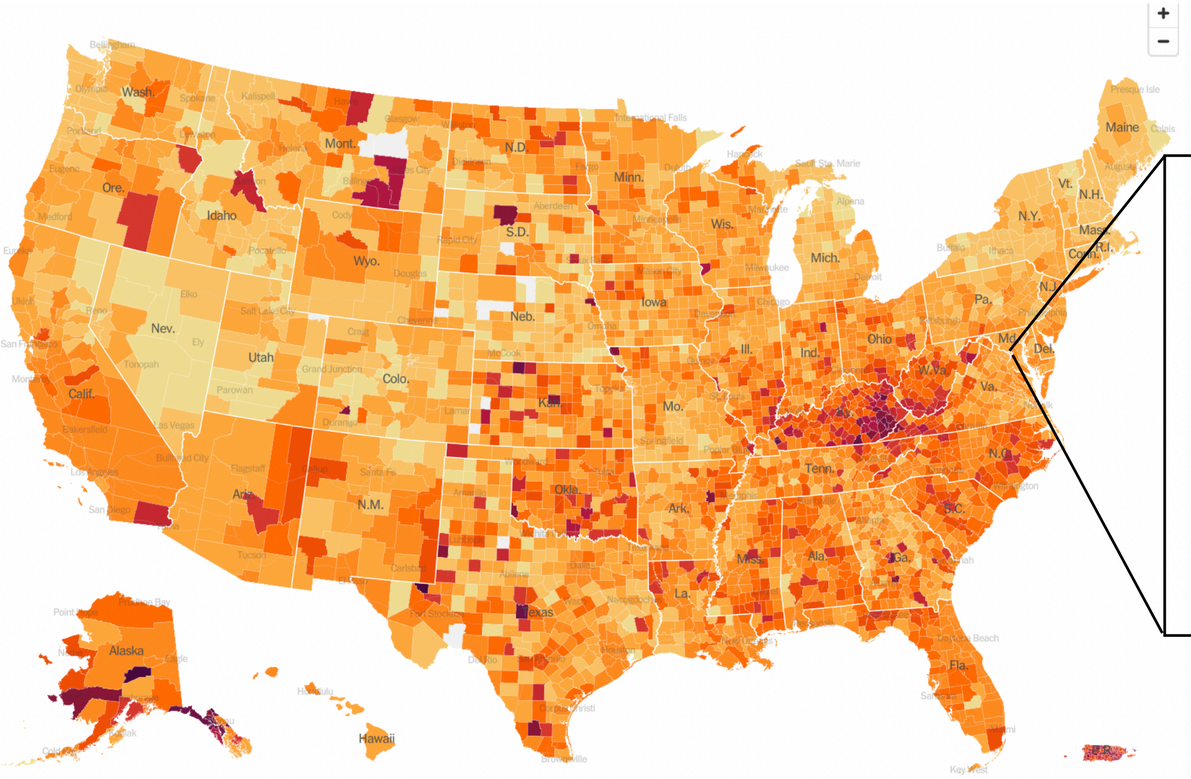
Motivation: Fine-scale heterogeneity in disease transmission & risk

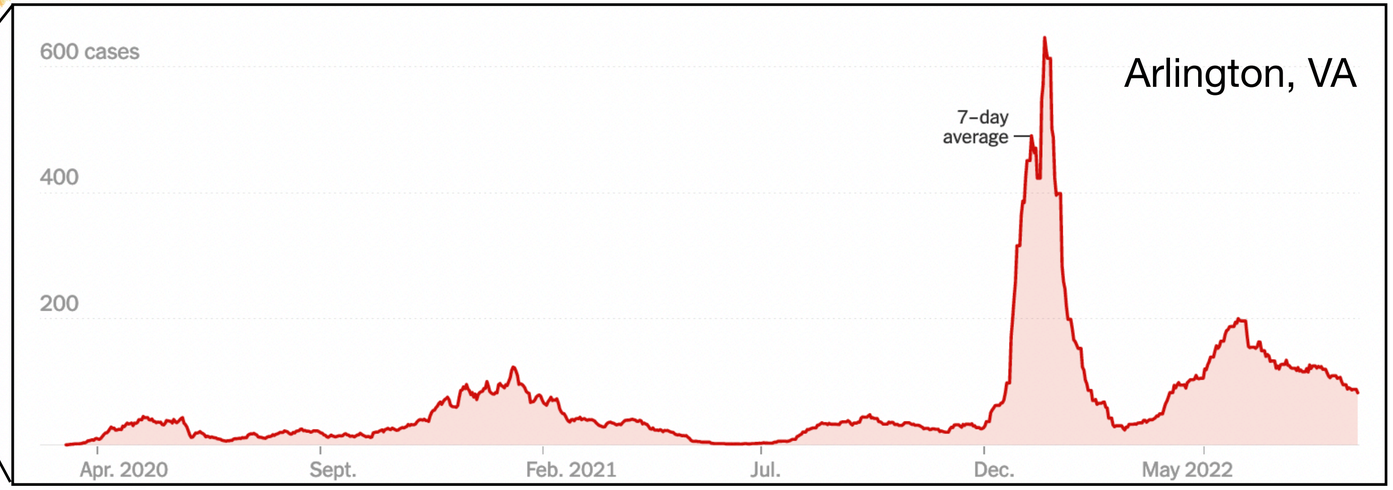
Fine-scale spatial clustering of measles nonvaccination that increases outbreak potential is obscured by aggregated reporting data

Masters et al. (2020)

Ignoring spatial heterogeneity in drivers of SARS-CoV-2 transmission in the US will impede sustained elimination

Susswein et al. (2021)

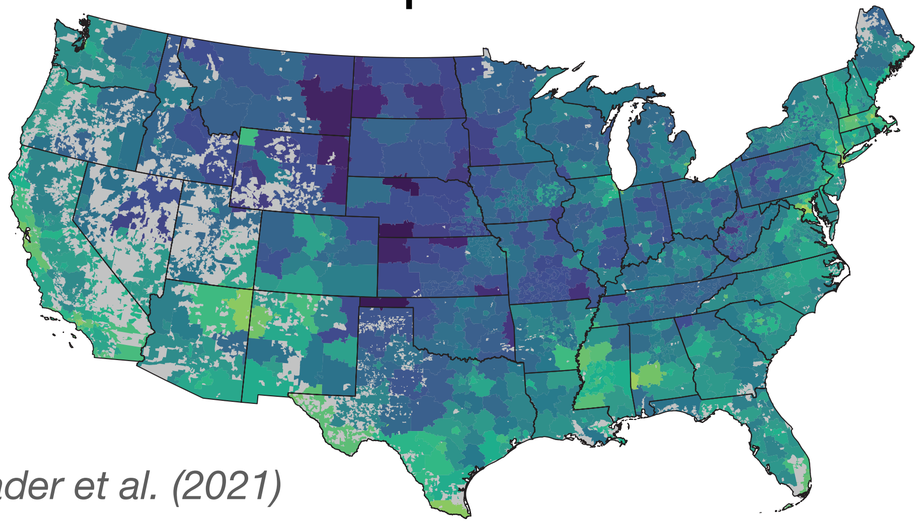




New York Times

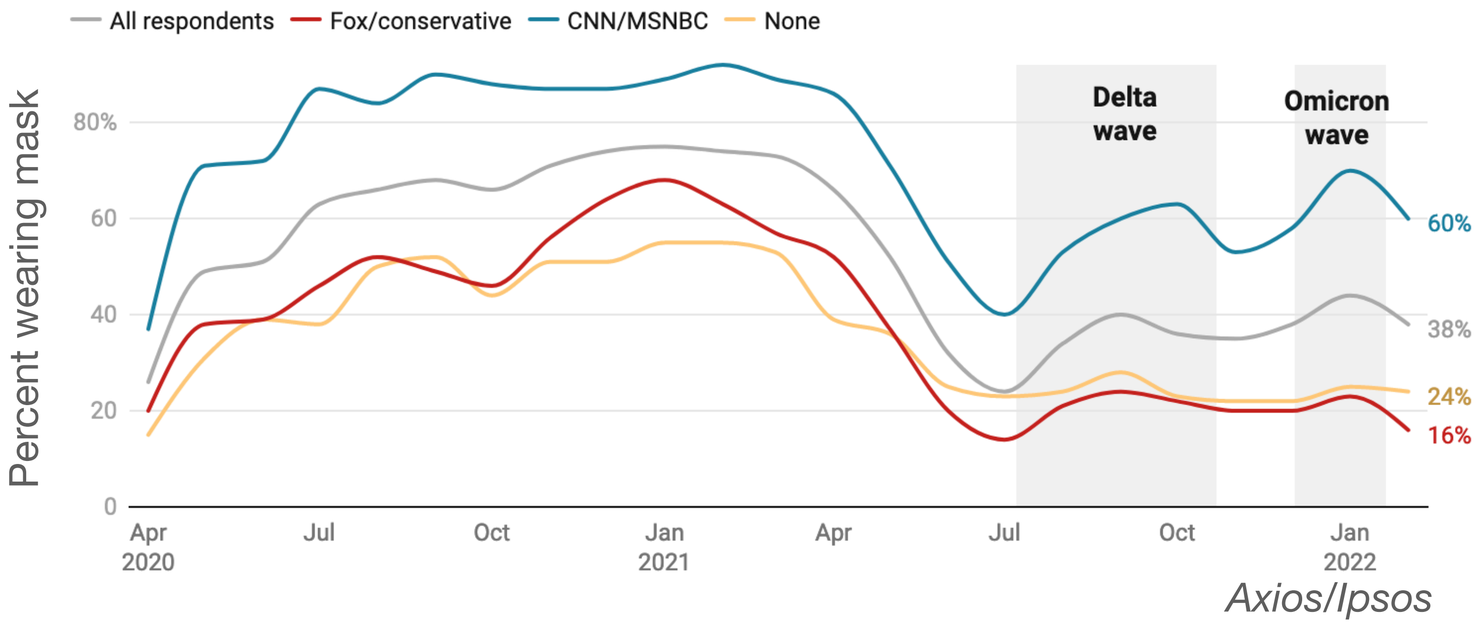
Contribution

space



Rader et al. (2021)

time



Axios/Ipsos

bias

Unrepresentative big surveys significantly overestimated US vaccine uptake

Bradley et al. (2021)

Goal

Develop fine-scale, debiased spatiotemporal estimates of mask-wearing

Methods

COVID-19 Trends and Impacts Survey, Sept. 2020 - May 2021

C14 **In the past 5 days,** how often did you wear a mask when in public?

- ○ All the time (1)
- ○ Most of the time (2)
- ○ Some of the time (3)
- ○ A little of the time (4)
- ○ None of the time (5)
- ○ I have not been in public during the past 5 days (6)

Methods

COVID-19 Trends and Impacts Survey, Sept. 2020 - May 2021

1. Dichotomize responses

C14 **In the past 5 days,** how often did you wear a mask when in public?

- ○ All the time (1) } masking
- ○ Most of the time (2) } masking
- ○ Some of the time (3) } not masking
- ○ A little of the time (4) } not masking
- ○ None of the time (5) } not masking
- ○ ~~I have not been in public during the past 5 days (6)~~

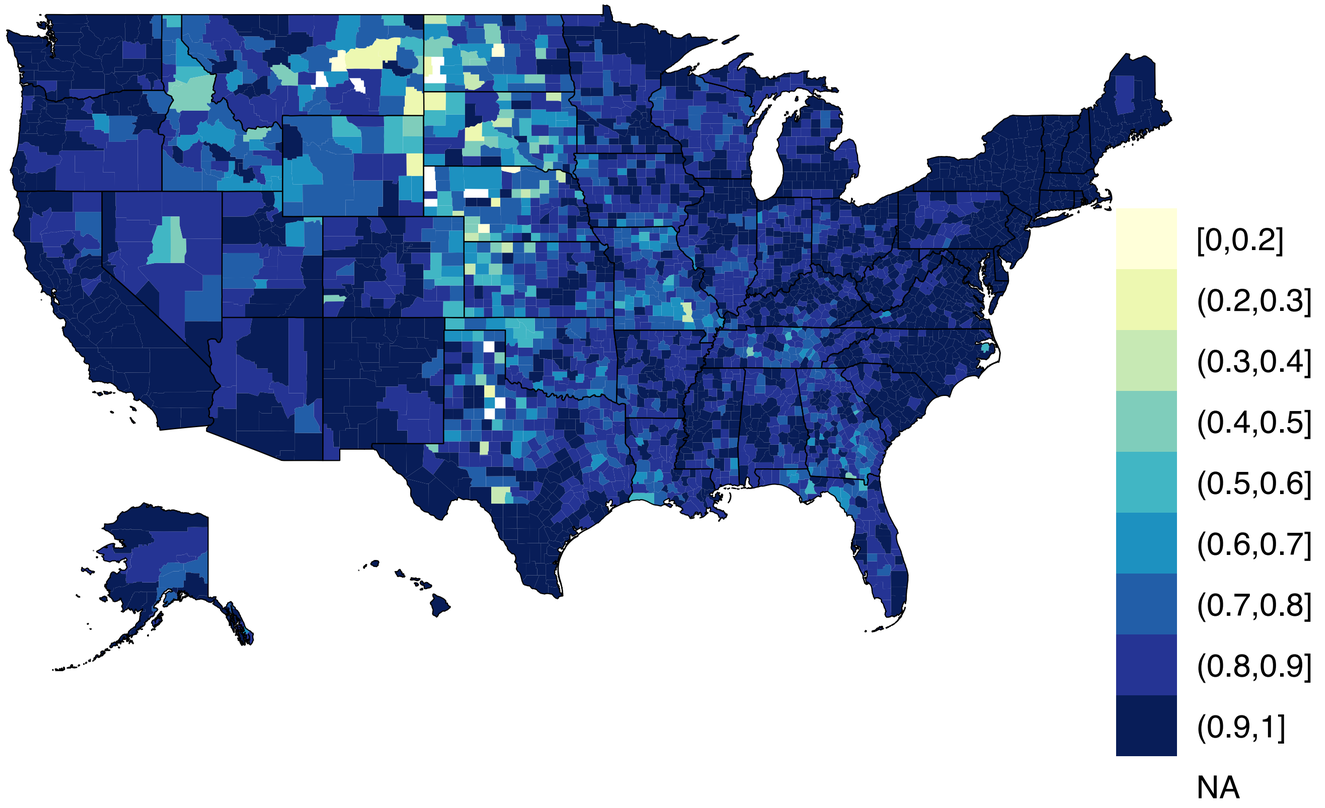
Methods

COVID-19 Trends and Impacts Survey, Sept. 2020 - May 2021

1. Dichotomize responses

2. Aggregate to county-month

Observed masking proportion by county for Feb. 2021



Methods

COVID-19 Trends and Impacts Survey, Sept. 2020 - May 2021

1. Dichotomize responses

2. Aggregate to county-month

3. Bayesian binomial regression

$$M_i \sim Binomial(N_i, p_i)$$

$$\text{logit}(p_i) \sim Normal(\mu_i, \sigma)$$

$$\mu_i = \beta_0 + \beta_1 \cdot \text{population density}$$

Methods

COVID-19 Trends and Impacts Survey, Sept. 2020 - May 2021

1. Dichotomize responses
2. Aggregate to county-month
3. Bayesian binomial regression
4. Raking & resampling

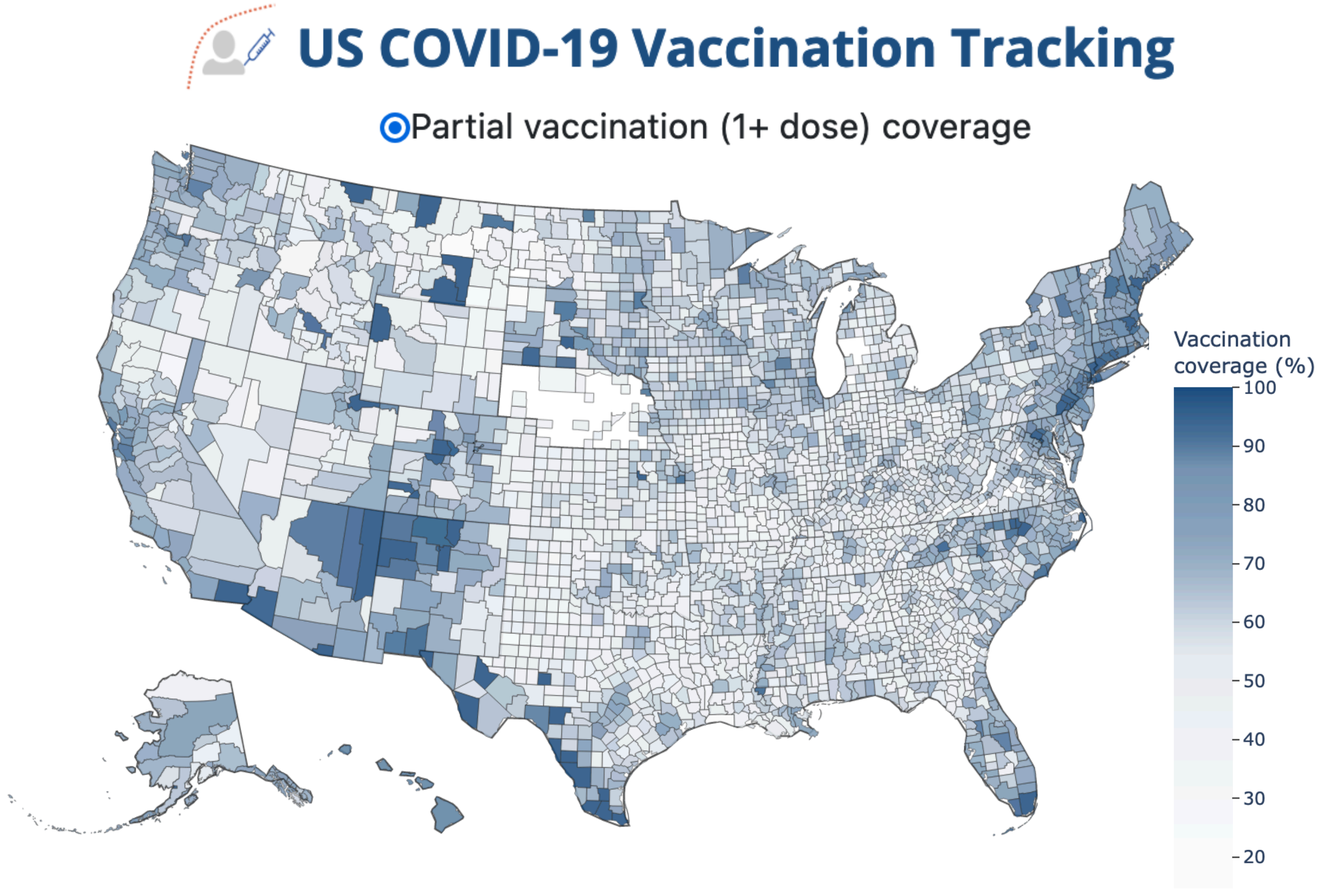
age gender education

https://www.freepik.com/free-vector/diverse-crowd-people-different-ages-races_7732608.htm

Methods

COVID-19 Trends and Impacts Survey, Sept. 2020 - May 2021

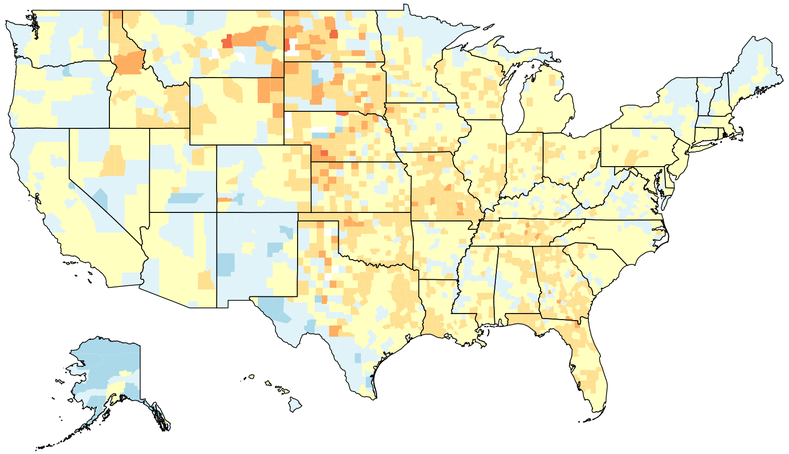
1. Dichotomize responses
2. Aggregate to county-month
3. Bayesian binomial regression
4. Raking & resampling
5. Debias with ground-truth vaccination data



bias = CTIS vaccination prop. — true vaccination prop.

Addressing survey biases

Model smooths over noisy proportions from small sample sizes



Binomial regression model

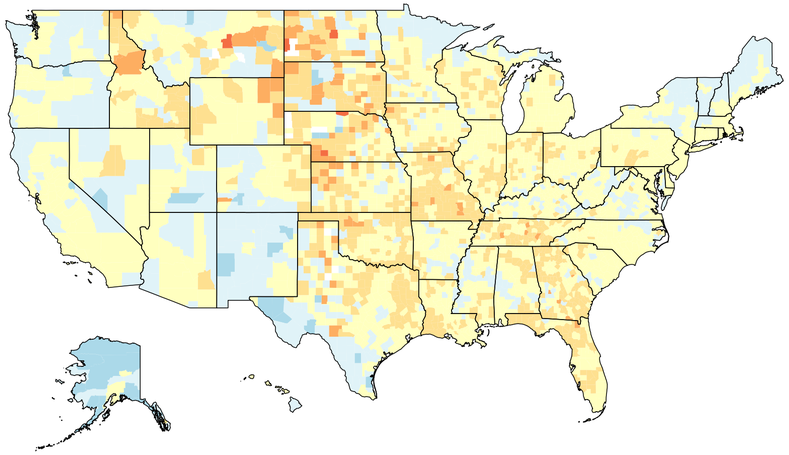
Difference from observed masking proportion

[–1,–0.75] (–0.75,–0.5] (–0.5,–0.25] (–0.25,–0.05] (–0.05,0.05] (0.05,0.25] (0.25,0.5] (0.5,0.75] (0.75,1] NA

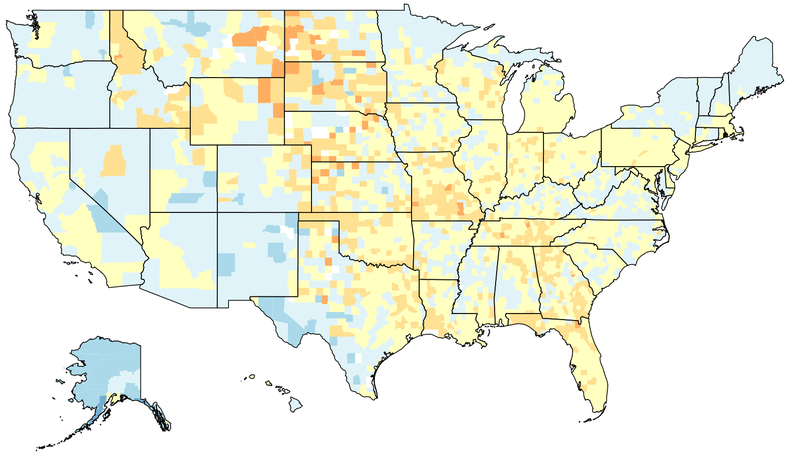
modeled > observed ⟷ modeled < observed

Addressing survey biases

Unrepresentative samples slightly overestimate masking



Binomial regression model



with raking

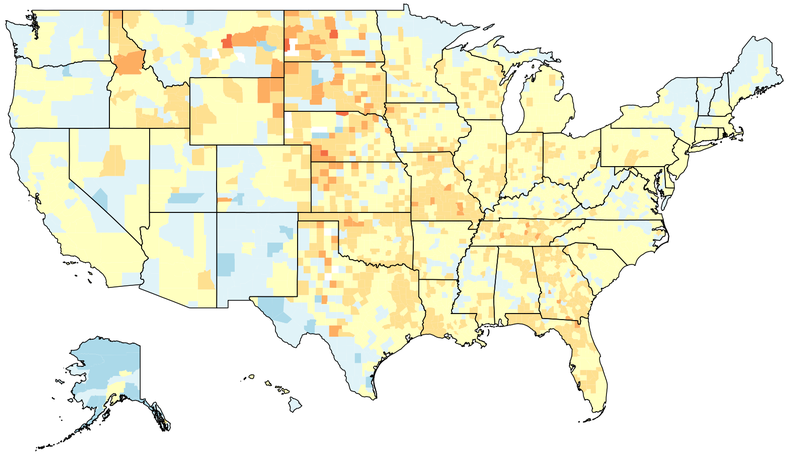
Difference from observed masking proportion

[–1,–0.75] (–0.75,–0.5] (–0.5,–0.25] (–0.25,–0.05] (–0.05,0.05] (0.05,0.25] (0.25,0.5] (0.5,0.75] (0.75,1] NA

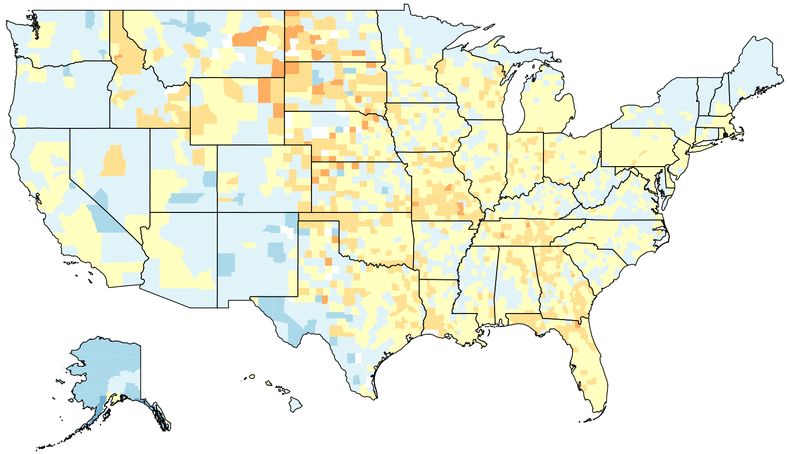
modeled > observed ⟷ modeled < observed

Addressing survey biases

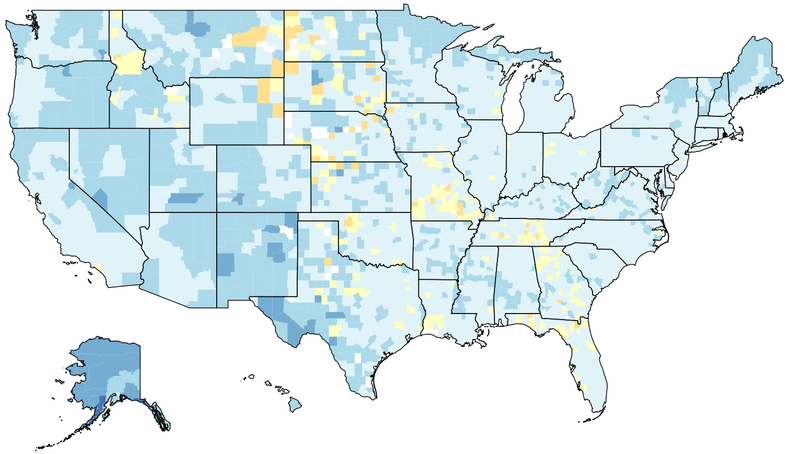
Social desirability and non-response biases overestimate masking



Binomial regression model



with raking



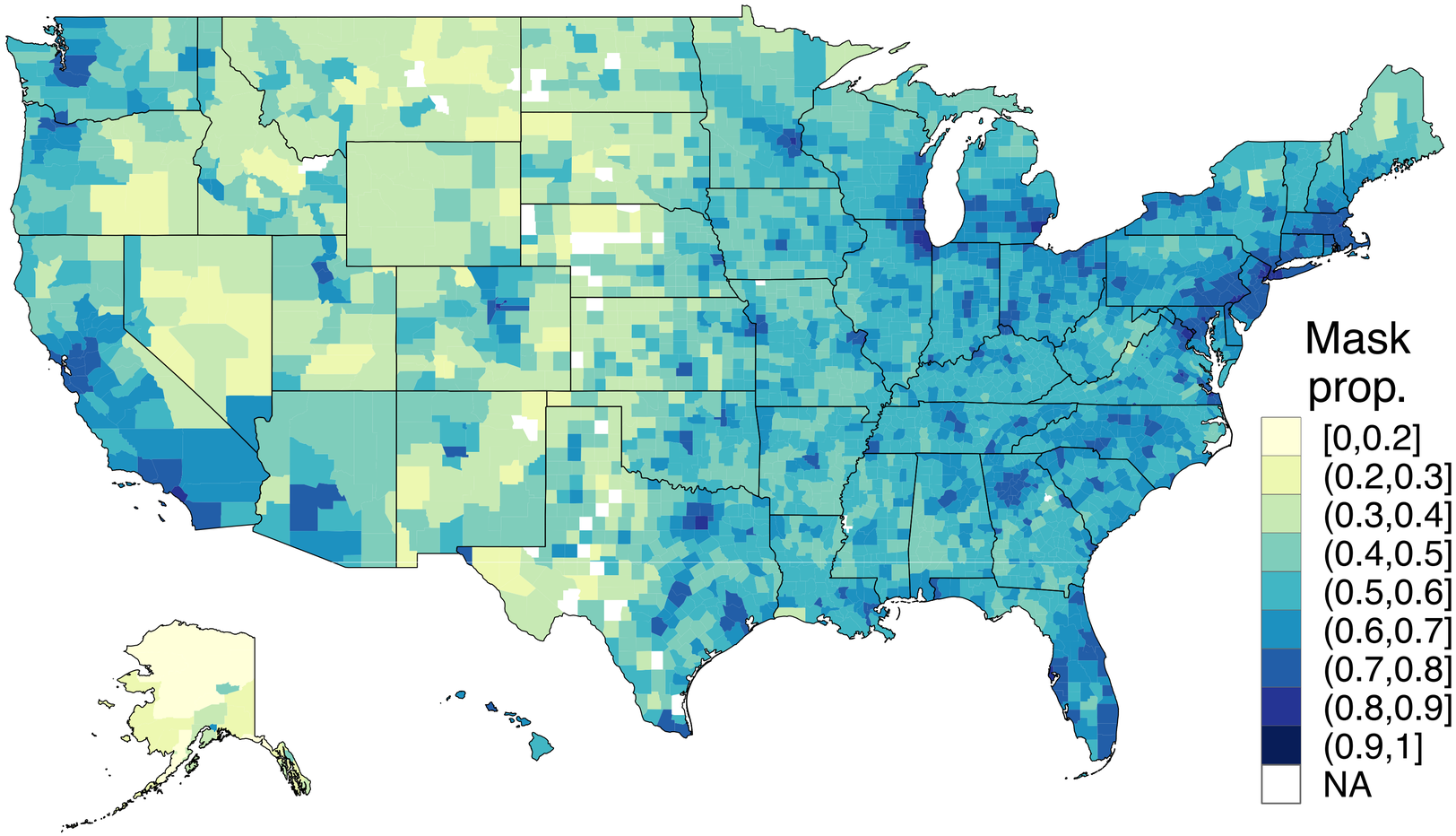
with raking and debiasing

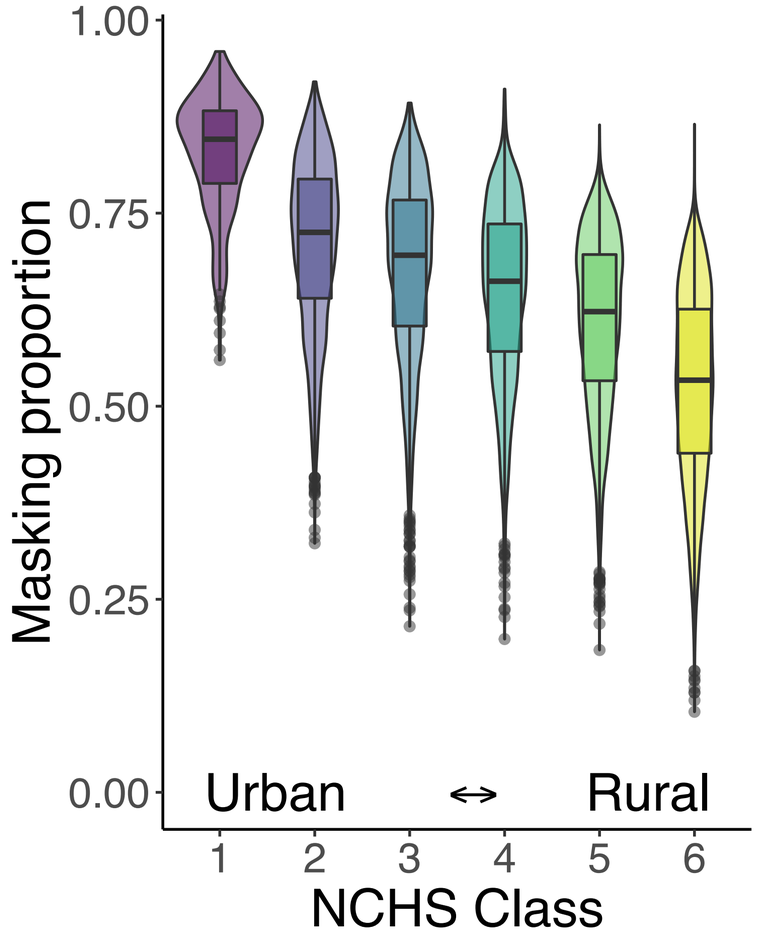
Difference from observed masking proportion

[–1,–0.75] (–0.75,–0.5] (–0.5,–0.25] (–0.25,–0.05] (–0.05,0.05] (0.05,0.25] (0.25,0.5] (0.5,0.75] (0.75,1] NA

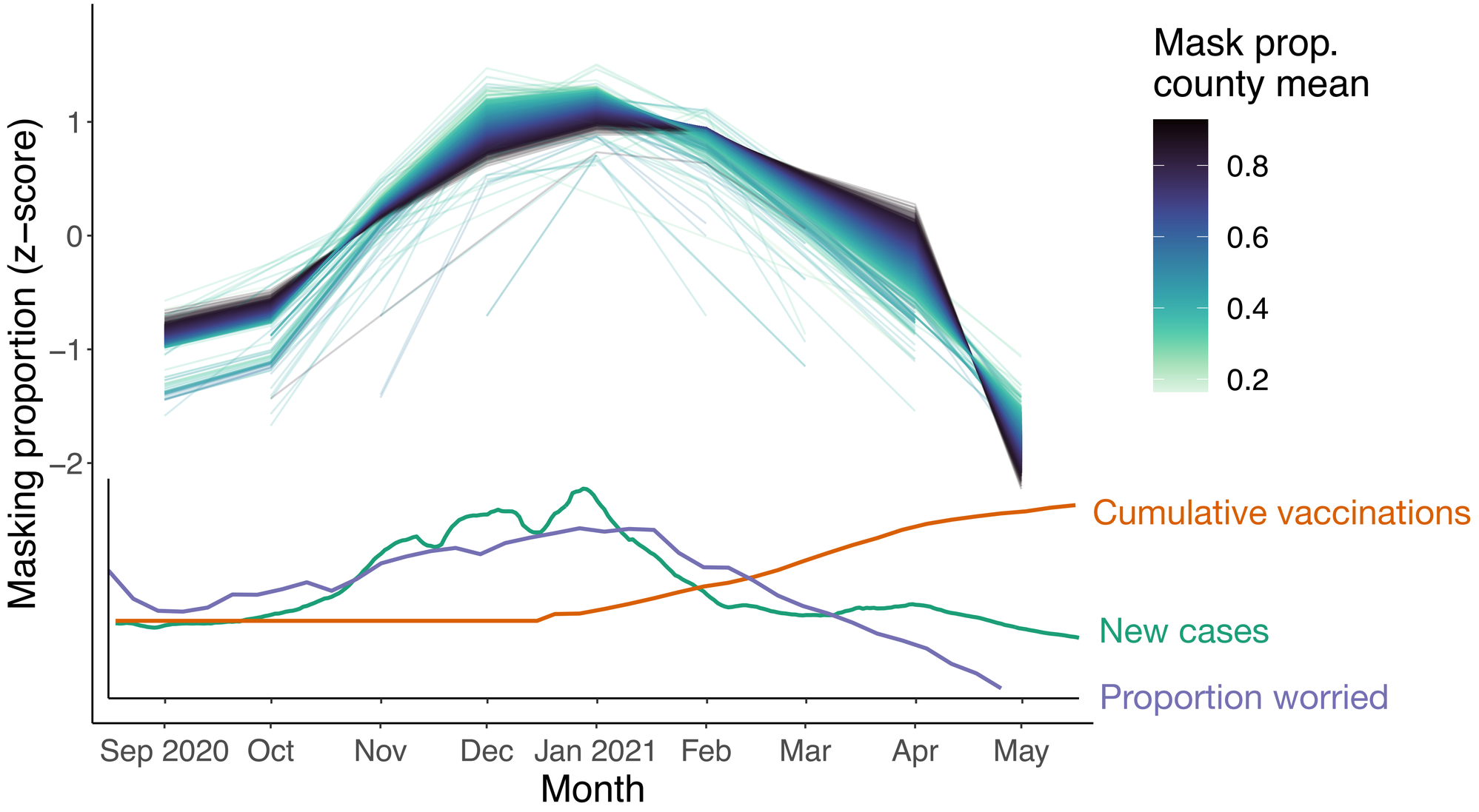
modeled > observed ⟷ modeled < observed

Masking is spatially heterogeneous and higher in urban areas





Masking exhibits some variability over time, mirroring national cases & vaccines



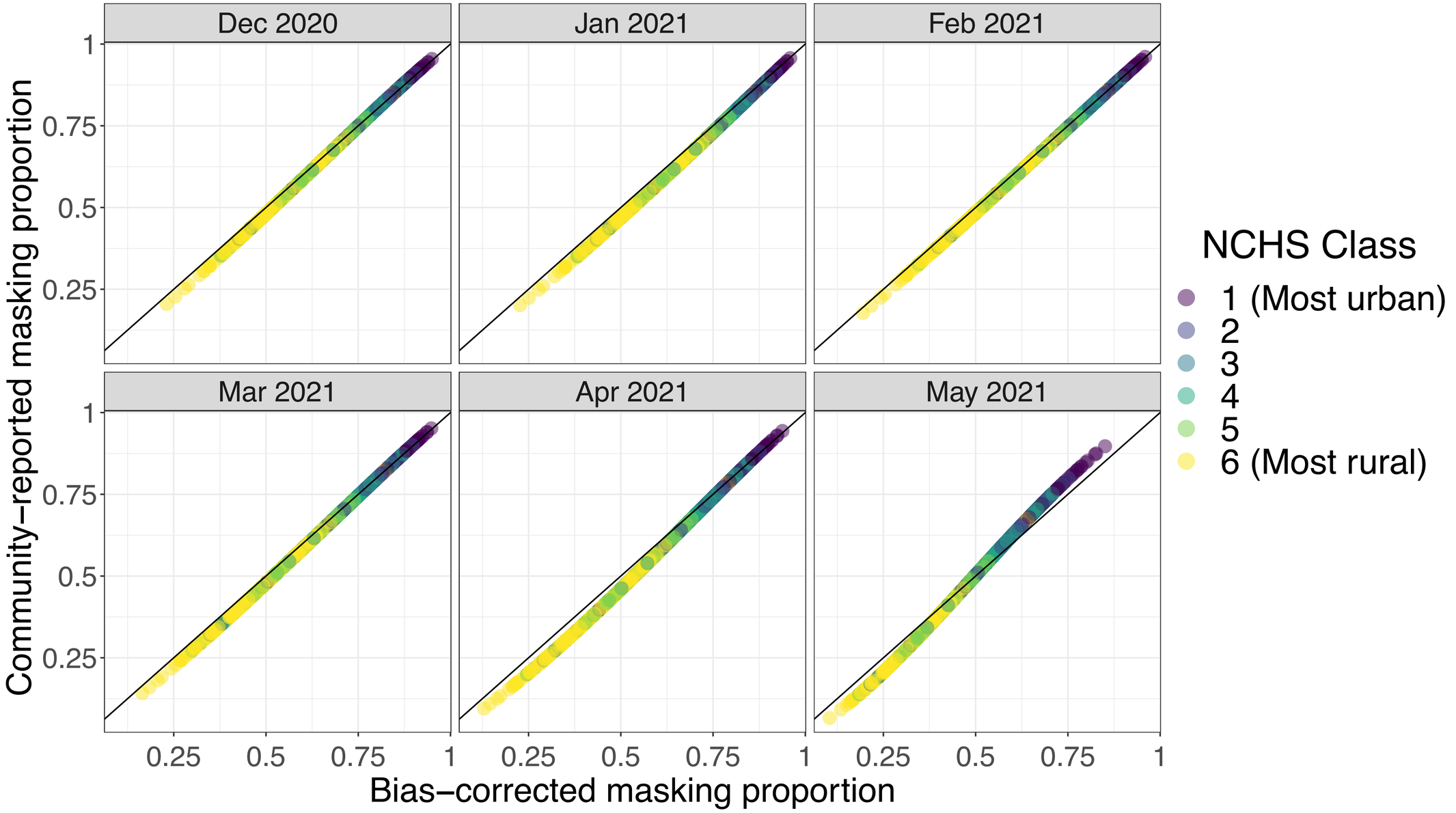
Validation

Can social sensing approaches help reduce survey bias?

C16 In the past 7 days, when out in public places where social distancing is not possible, about how many people would you estimate wore masks?

- ○ All of the people were wearing masks (1)
- ○ Most of the people were wearing masks (2)
- ○ Some of the people were wearing masks (3)
- ○ A few of the people were wearing masks (4)
- ○ None of the people were wearing masks (5)
- ○ I have not been out in public places in the past 7 days (6)

Community estimates are a good predictor of debiased self-reported masking



Takeaways

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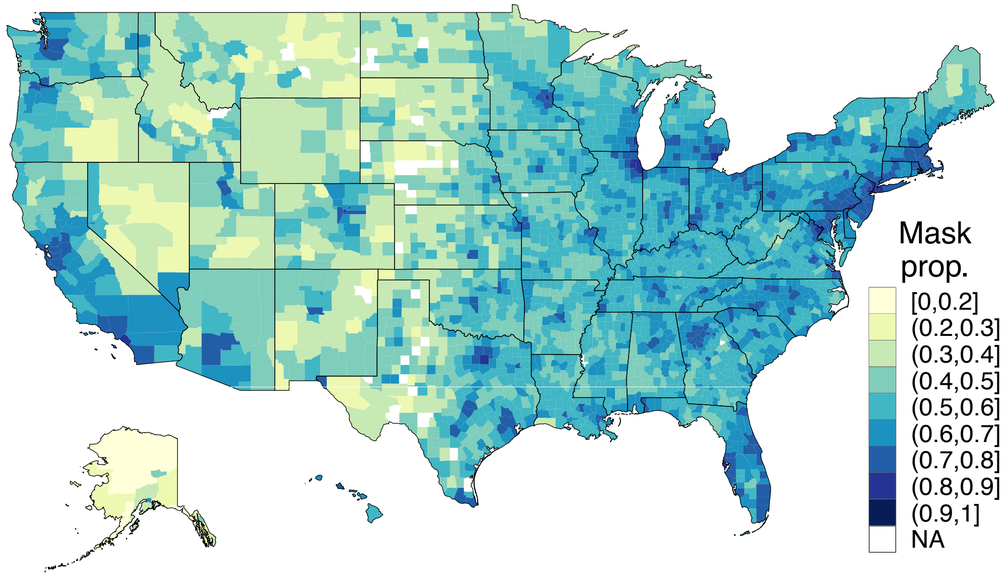
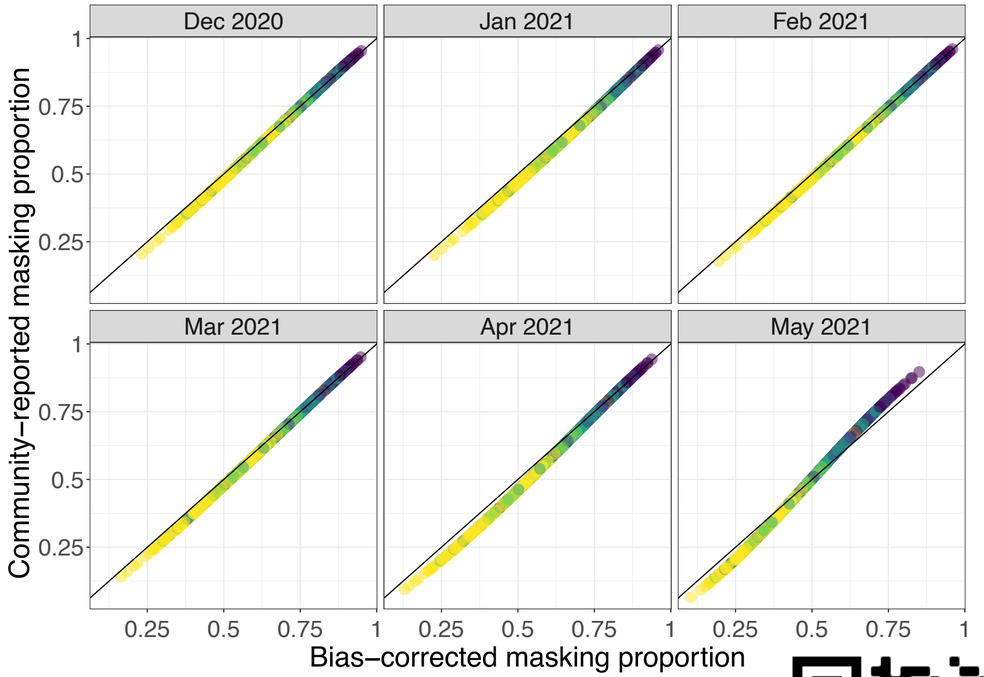
Masking varies spatiotemporally across the U.S.



Social sensing may help address survey biases



Fine-scale spatiotemporal behavioral data are critical to understanding disease-behavior dynamics

preprint