Contact patterns in the US vary over space but not time

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pandemic

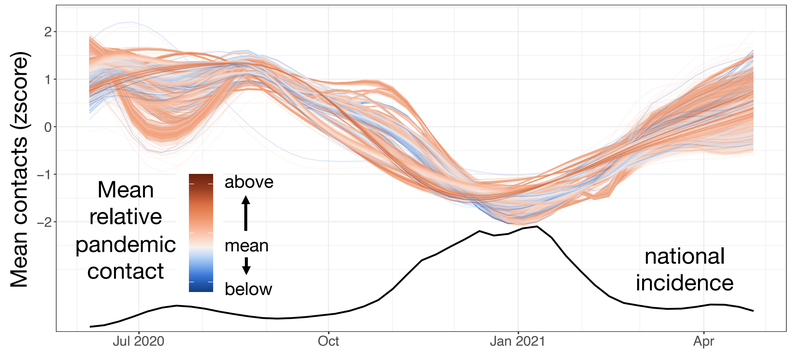


Fig 1. Counties have **similar contact dynamics over time**, with a uniform decrease in winter 2020-21. Summer 2020 case surges in some counties/states likely drove decreased contact at that time.

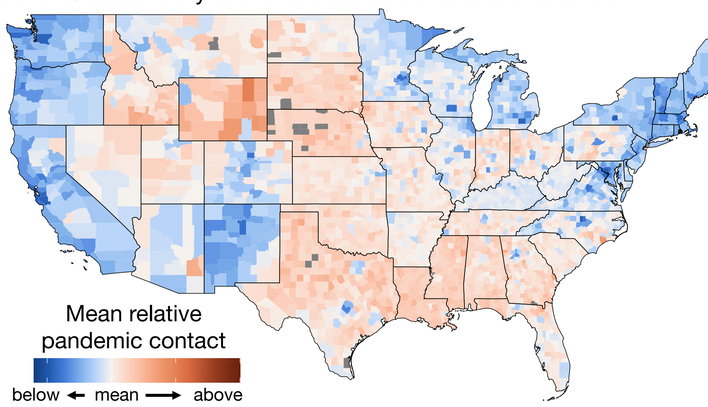


Fig 3. Mean **non-household contacts** from Oct 2020 – Apr 2021 are **spatially heterogeneous.** National mean = 8.7.

non-pandemic

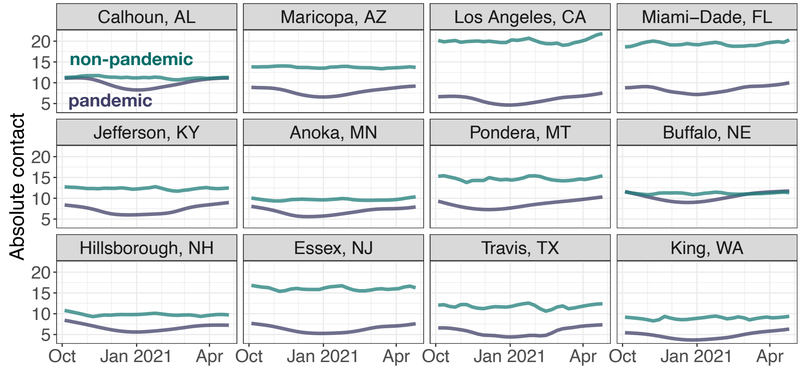


Fig 2. **Contact is relatively stable over time** when we **remove the effect of disease** (see methods).

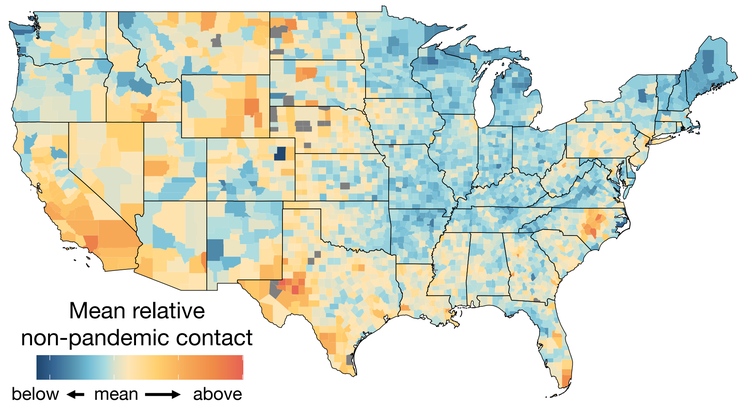


Fig 4. Mean non-household **contacts remain spatially heterogeneous after controlling for disease** and integrating with pre-pandemic mobility data. National mean = 11.

contact structures disease risk

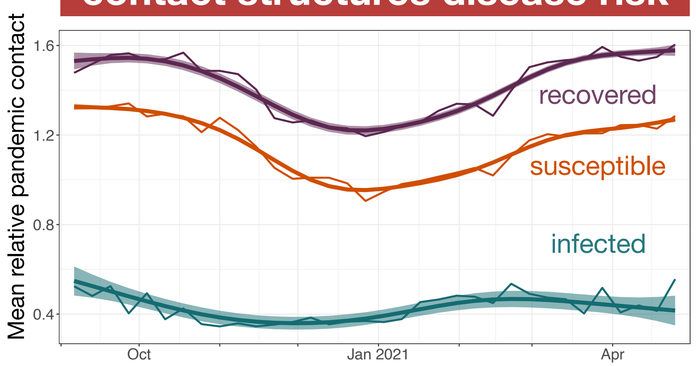
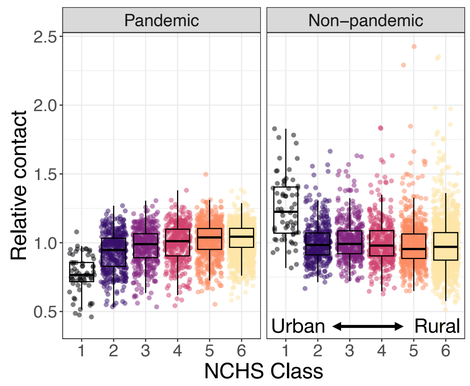


Fig 5. During the **pandemic,** ⟶ **urban counties** had **fewer contacts,** though under **non-pandemic** conditions **urban counties** will **have more contacts.**

⟵ Fig 6. Recently **infected** (< 14 days ago) respondents **have the fewest contacts**, **followed by susceptible**, **then recovered** individuals.



motivation

- Respiratory pathogens rely on **close contact** for transmission
- Contact patterns are **heterogeneous**, as shown by the POLYMOD study conducted *in Europe over 15 years ago*
- **Lack of recent data in the US** leaves open questions about how contact patterns vary across **space**, **seasons**, & **disease states**
- This information is key to designing **targeted disease control** strategies and developing accurate **estimates of transmission risk**, that account for individual **heterogeneities** & **spatial structure**

data

COVID-19 Trends and Impacts Survey

May 2020 – April 2021

≈ 13 million respondents age 18+, post-stratified by age & gender

of *non-household* contacts in last 24 hrs (> 5 mins, < 6ft)

methods

Figs 1, 3, 5. Spatiotemporal GAMs by state with county random effects.

Figs 2, 4, 5. Linear regression of county mean contact predicted by county & national incidence, and state average Oxford Stringency Index. County predicted contact at zero disease is then scaled by the ratio of fall 2019 to 2020 county mobility.

Fig 6. National GAM, factor-smooth interaction with disease state. Disentangled from behavior change using mechanistic models (not shown).

takeaways

- After controlling for disease, non-household contacts **exhibit spatial heterogeneity with higher contact in urban areas** and **temporal stability**
  - ➢ During the COVID-19 pandemic, contact was lower in urban areas and varied with incidence
  - ➢ Setting of contact may be driving non-pandemic disease trends more than amount of contact
  - ➢ Consider including this spatial variability in models & exploring how these differences contribute to observed disease dynamics
- Empirical **data supports network epidemiology theory** that high degree nodes will be infected first
  - ➢ Need to incorporate this phenomenon into disease management efforts & data interpretation (e.g., analysis of contact tracing data, adaptive vaccination policy)