Characterizing heterogeneities in contact patterns

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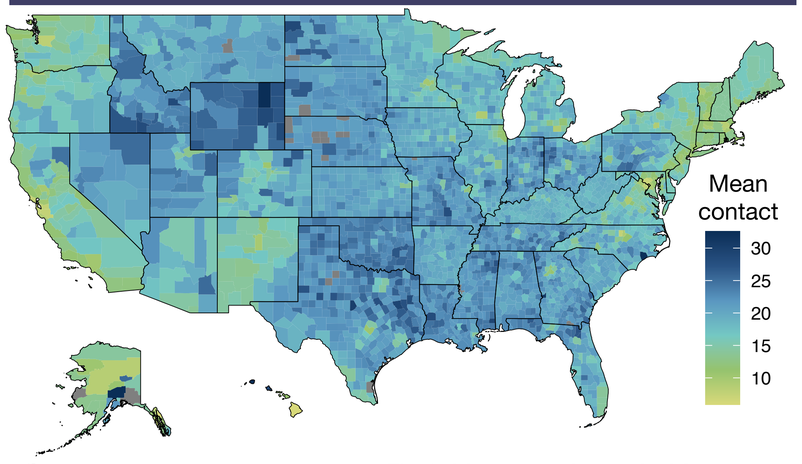
contact is spatially heterogeneous



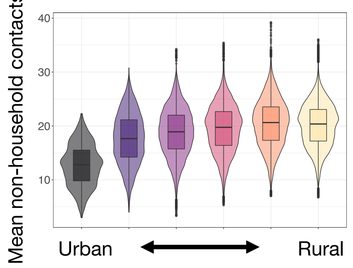


Fig 1. Mean **non-household contacts** from May 2020 through April 2021 are **spatially heterogeneous** with a moderate **urban-rural gradient.**

Fig 3. **Contact is relatively constant over time** when we remove the effect of the pandemic (see methods). Future studies should confirm this finding. →

contact is temporally stable

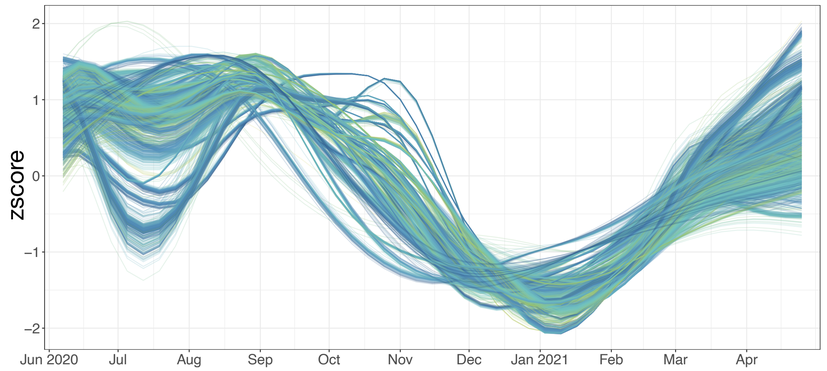
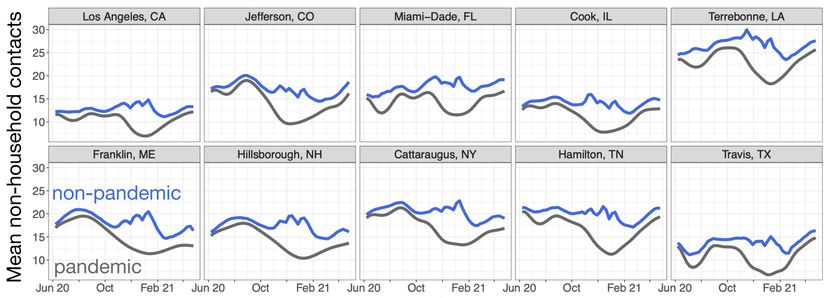


Fig 2. Counties have **similar contact dynamics over time**, with a uniform decrease in winter 2020-21. Summer 2020 case surges in some counties/states likely drove decreased contact at that time.



contact varies by demography

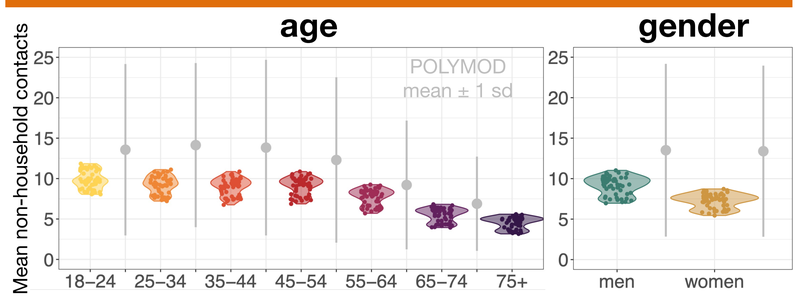
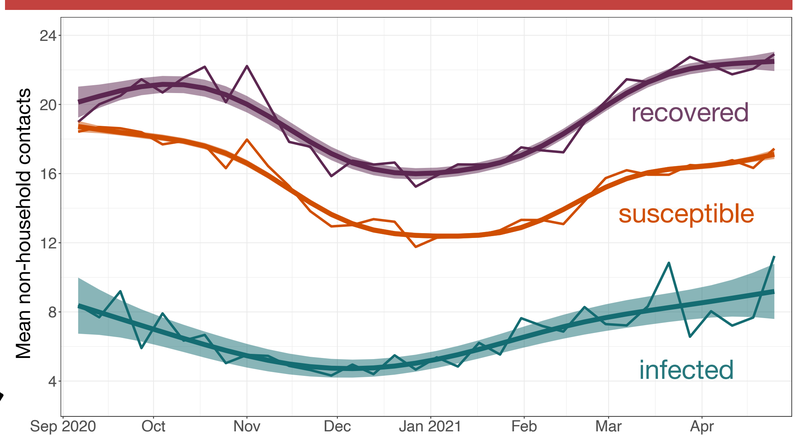


Fig 4. Mean number of **contacts decrease with age**, while **men** tend to have **more contacts than women**.

Fig 5. Recently **infected** (< 14 days ago) respondents **have the fewest contacts**, **followed by susceptible**, **then recovered** individuals. →

contact structures disease risk



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**, & **demographic groups**
- 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&2. Spatiotemporal GAMs by state with county random effects

Fig 3. Linear regression with partial pooling, county random effect:
- response: county mean contact
- predictors: county, state, & national incidence, urban/rural NCHS class, interaction between urban/rural class & national incidence

Fig 4. Weekly county means post-stratified by age & gender to match ACS estimates, censored at 29 contacts for POLYMOD comparison

Fig 5. National GAM, factor-smooth interaction with disease state. Disentangled from behavior change using mechanistic models (not shown)

takeaways

- Non-household contacts **exhibit spatial heterogeneity with lower contact in urban areas** and **similar temporal dynamics** associated with disease
  - ➢ Consider including this variability in models & exploring how these differences contribute to observed disease dynamics
- **Contact is seasonally stable**, after controlling for disease
  - ➢ Need non-pandemic data to validate this finding
- 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)