A Network-Based Perspective on Healthcare Worker Internal Migration and Its Implications for Community Health

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Goal and Networks

- **Our goal is to estimate associations of internal migration of healthcare workers on health outcomes in the United States**
- **We conceptualize places where healthcare workers establish networks**
  - Cummins et al. (2007) outlined a spatial concept that recognizes the interconnected nature of places as nodes in networks
  - We place migration destinations as nodes in a network to quantify and model its effect on health outcomes
- **Teaching hospital residency programs** offer a unique, systematic, and well-defined way that stimulates networks
  - They pull large numbers of medical professionals from all levels
  - We used these programs to build the frame of healthcare workers migration network

Research Framework

- We turn to **social determinants of health** to better understand how internal migration of healthcare workers affect health outcomes
- The **County Health Ranking & Roadmaps (CHR&R)** by the University of Wisconsin Population Health Institute
  - Provides multiple factors that influence health
  - Uses several national and state data sources to rank counties by health outcomes
  - However, it does not specifically account for healthcare workforce migration
- We add our indicator of places' position in the conceptualized healthcare worker **migration network**
  - We explicitly model the effects of migration networks on health outcomes
- This brings healthcare workforce mobility into focus and provides another topic for **policymakers** to address related to community health outcomes

Data

- American Community Survey (ACS)
  - Obtain in-migration flows for each of the 1,005 groups of Public Use Microdata Areas (MIGPUMAs)
  - Calculate their network positions according to teaching hospital residency programs
- County Health Ranking & Roadmaps (CHR&R)
  - Health control variables
  - Health outcomes (here we focus on premature death)
- Many measures produced by CHR&R have undergone substantial changes related to data sources or methods
  - We only utilize measures that have remained consistent over time, so we focus on the period from 2013 and 2018

Methods

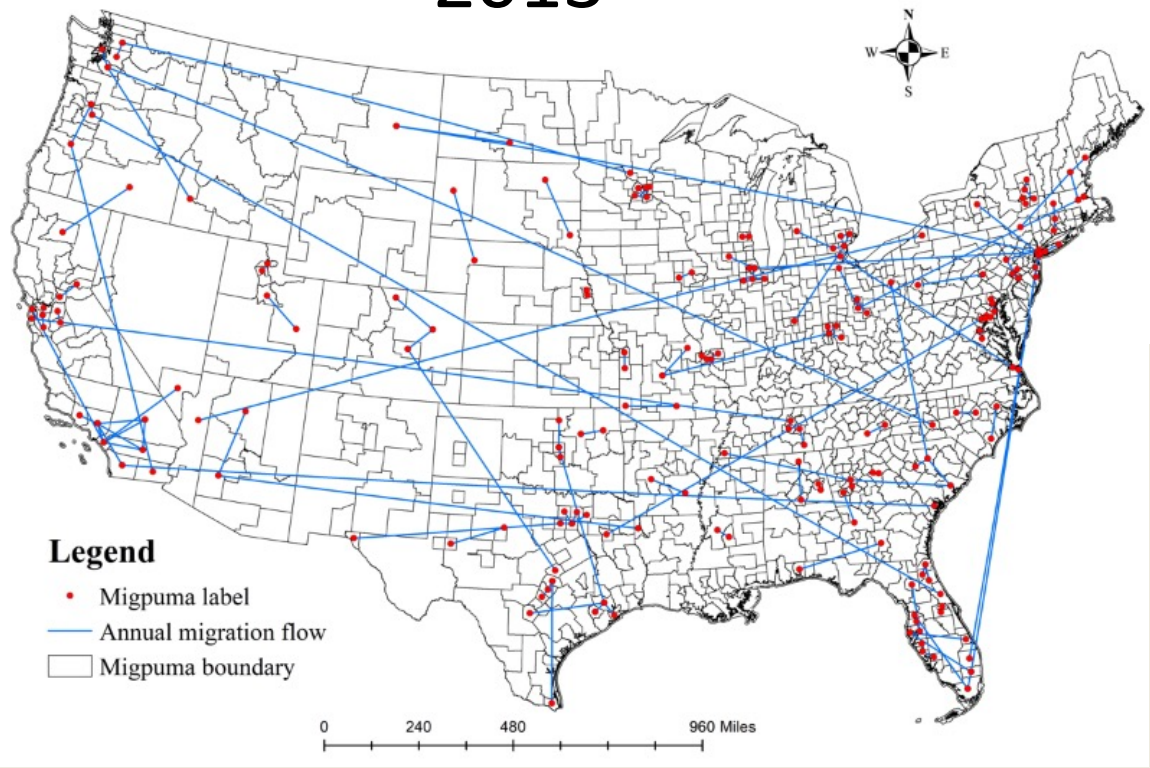
Network Position (Tian et. al, 2021, 2023)

$$NP_i = \alpha \frac{C_i^D - C_{min}^D}{C_{max}^D - C_{min}^D} + \beta \frac{C_i^S - C_{min}^S}{C_{max}^S - C_{min}^S}, \quad \text{Where } C_i^D = \frac{\sum_{i \le j} a_{ij}}{n-1} \text{ and } C_i^S = \frac{\sum_{i \le j} w_{ij}}{n-1}$$

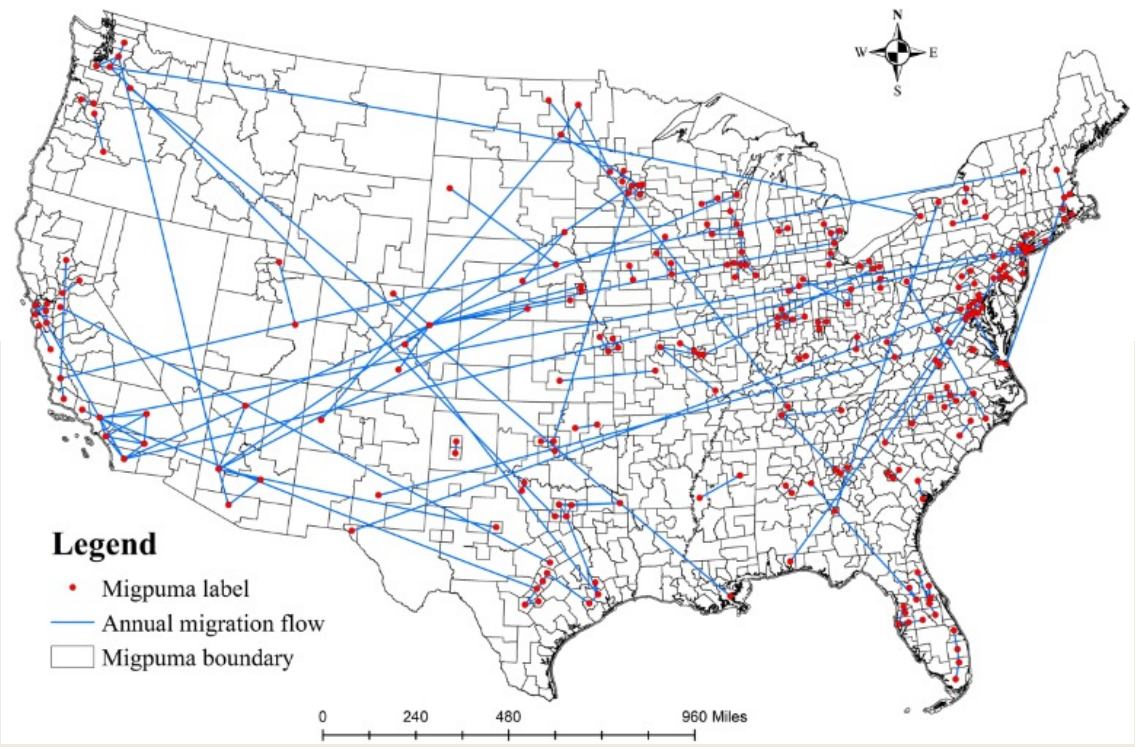
- Nodes: MIGPUMAs with at least one teaching hospital residency program and healthcare worker migration in-flow
- Degree (C_i^D): Number of connections each MIGPUMA has in the network
  - a_{ij}: 1 if nodes *i* and *j* connect to each other, otherwise equals to zero
  - *n*: number of nodes in the network
- Strength (C_i^S): In-migration flows between the two nodes
  - w_{ij}: number of healthcare worker migrants between nodes *i* and *j*
  - *n*: number of nodes in the network

Healthcare Worker Migration Network

2013



2018



Dots: Centroids of MIGPUMAs with teaching hospitals and healthcare worker migration flows greater than the average plus two standard deviations

Lines: Migration flows between two MIGPUMAs

OLS Regressions

- We tested different community health outcomes as dependent variables
  - We focus on results for log of person-years of premature death
    - Log of years of potential life lost before age 75 per 100,000 population

- Main independent variable
  - Log of healthcare worker migration network position

- Several control variables to represent health behaviors, clinical care, socioeconomic context, and physical environment

Effects on log of person-years of premature death

- Premature death (life lost before age 75 for 100,000 population) was 8,527 years on average for all counties in 2019
- A 1% increase of network position
  - Would reduce 0.011*8,527=94 years of life lost per 100,000 population
- More than half of all residents lived in just 143 large counties in 2017
  - The median population for a large county was over 800,000
  - A 1% increase of network position would save on average 94*8=752 total years of lives lost before reaching age 75 for a county with the median population

Independent Variables	Health Variables	Health Variables & Network Position
Log of healthcare worker migration network position	**——**	**–0.011*****
Proportion of physical nonactivity	1.938***	1.882***
Log of sexually transmitted infections	–0.096***	–0.088***
Proportion of teen birth	0.593***	0.562***
Log of area primary care physician to population ratio	0.017**	0.013*
Proportion of uninsured population	–0.351***	–0.278***
Proportion of unemployed population	0.075	0.043
Log of violent crimes	0.040***	0.044***
Proportion of children in poverty	0.499***	0.484***
Proportion of single parent households	0.848***	0.845***
Air population days	–0.001	–0.0003
Year		
2013	ref.	ref.
2014	0.012	0.013
2015	0.014	0.015
2016	0.022**	0.022**
2017	0.056***	0.057***
2018	0.082***	0.083***
R-squared	0.778	0.779
Adjusted R-squared	0.777	0.778

*Significant at p<0.10; **Significant at p<0.05; ***Significant at p<0.01.

Conclusions

- Using network nodes and positions to model the relational aspects of space offers a framework for understanding the effects of internal migration of the healthcare workforce

- Places with higher healthcare workforce migration networks have better population health outcomes as measured by years lost due to premature death

- Community leaders and policymakers should give attention to creating positive environments for healthcare workers to improve community health outcomes