Measuring Multi-Sector Contributions to Public Health Delivery Systems & Population Health

Glen P. Mays, University of Kentucky

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UK HMP Seminar • 4 March 2016
How do we support effective population health improvement strategies?

- Designed to achieve **large-scale** health improvement: neighborhood, city/county, region
- Target **fundamental** and often multiple determinants of health
- Mobilize the **collective actions** of multiple stakeholders in government & private sector
  - Resource commitments
  - Infrastructure requirements

Fundamental challenge: overcoming collective action problems

- Incentive compatibility → public goods
- Concentrated costs & diffuse benefits
- Time lags: costs vs. improvements
- Uncertainties about what works
- Asymmetries in information
- Difficulties measuring progress
- Weak and variable institutions & infrastructure
- Imbalance: resources vs. needs
- Stability & sustainability of funding

Can **public health** solve collective action problems?

**Foundational Public Health Services**

- Mobilize multi-sector implementation
- Develop plans & policies
- Engage stakeholders
- Recommend actions
- Monitor, evaluate, feedback
- Assess needs & risks

What foundational services are needed to support collective actions in health?

Public health as chief health strategist for the delivery system:

- Articulate population health needs & priorities
- Engage community stakeholders
- Plan with clear roles & responsibilities
- Recruit & leverage resources
- Develop and enforce policies
- Ensure coordination across sectors
- Promote equity and target disparities
- Support evidence-based practices
- Monitor and feed back results
- Ensure transparency & accountability: resources, results, ROI
How do we deploy foundational public health services across the US?

2012 Institute of Medicine Recommendations

- Identify the components and costs of a minimum package of public health services
  - Foundational capabilities
  - Basic programs
- Create shared federal-state financing
- Identify how to implement these services in every U.S. state and community
- Expand research on costs and effects of public health delivery

A fundamental problem: wide variation in current public health capacity

Gini = 0.485
A fundamental problem: wide variation in current public health capacity

Source: 2013 NACCHO National Profile of Local Health Departments Survey
Research questions of interest

- Which organizations contribute to the implementation of foundational public health activities in local communities?
- How do these contributions change over time?
  - Recession  |  Recovery  |  ACA implementation
- What are the health and economic effects attributable to these changes?
Data: public health delivery systems

National Longitudinal Survey of Public Health Systems

- Cohort of 360 communities with at least 100,000 residents
- Local public health officials report:
  - **Scope**: availability of 20 recommended public health activities
  - **Network**: organizations contributing to each activity
  - **Centrality of effort**: contributed by governmental public health agency
  - **Quality**: perceived effectiveness of each activity

** Expanded sample of 500 communities<100,000 added in 2014 wave
Data: community & market characteristics

- **Area Health Resource File**: physician, hospital and CHC supply; population size and demographics, socioeconomic status, racial/ethnic composition, health insurance coverage

- **NACCHO Profile data**: public health agency institutional and financial characteristics

- **CMS Cost Report & Impact File**: hospital ownership, market share, uncompensated care

- **CDC Compressed Mortality File**: Cause-specific death rates by county

- **Dartmouth Atlas**: area-level medical care spending/capita
Cluster and network analysis to identify “system capital”

Cluster analysis is used to classify communities into one of 7 categories of public health system capital based on:

- **Scope of activities** contributed by each type of organization
- **Density of connections** among organizations jointly producing public health activities
- **Degree centrality** of the local public health agency

Average public health system structure in 2014

Node size = degree centrality
Line size = % activities jointly contributed (tie strength)
What do we call a system that delivers a broad scope of foundational public health services through a dense network of multi-sector relationships?

COMPREHENSIVE
Prevalence of Public Health System Configurations 1998-2014

<table>
<thead>
<tr>
<th>Scope</th>
<th>Centrality</th>
<th>Density</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>Mod</td>
<td>High</td>
</tr>
<tr>
<td>High</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>High</td>
<td>High</td>
<td>Mod</td>
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<td>Mod</td>
<td>High</td>
<td>Low</td>
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<td>Mod</td>
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<td>Low</td>
<td>High</td>
<td>Low</td>
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<tr>
<td>Low</td>
<td>Low</td>
<td>Mod</td>
</tr>
</tbody>
</table>

- **Comprehensive** (High System Capital)
- **Conventional**
- **Limited**
One of RWJF’s 41 Culture of Health National Metrics

Access to public health

Overall, 47.2 percent of the population is covered by a comprehensive public health system. Individuals are more likely to have access if they are non-White (51.5 percent vs. 45.5 percent White) or live in a metropolitan area (48.7 percent vs. 34.1 percent in nonmetropolitan areas).

47.2% of population served by a comprehensive public health system

### Changes in system prevalence and coverage

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td><strong>Comprehensive systems</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% of communities</td>
<td>24.2%</td>
<td>36.9%</td>
<td>31.1%</td>
<td>32.7%</td>
<td>25.7%</td>
</tr>
<tr>
<td>% of population</td>
<td>25.0%</td>
<td>50.8%</td>
<td>47.7%</td>
<td>47.2%</td>
<td>36.6%</td>
</tr>
<tr>
<td><strong>Conventional systems</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% of communities</td>
<td>50.1%</td>
<td>33.9%</td>
<td>49.0%</td>
<td>40.1%</td>
<td>57.6%</td>
</tr>
<tr>
<td>% of population</td>
<td>46.9%</td>
<td>25.8%</td>
<td>36.3%</td>
<td>32.5%</td>
<td>47.3%</td>
</tr>
<tr>
<td><strong>Limited systems</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% of communities</td>
<td>25.6%</td>
<td>29.2%</td>
<td>19.9%</td>
<td>20.6%</td>
<td>16.7%</td>
</tr>
<tr>
<td>% of population</td>
<td>28.1%</td>
<td>23.4%</td>
<td>16.0%</td>
<td>19.6%</td>
<td>16.1%</td>
</tr>
</tbody>
</table>
Estimating delivery system effects

**Dependent variables:**
- *Health outcomes*: premature mortality (<75), infant mortality, death rates for heart disease, diabetes, cancer, influenza
- *Resource use*: Local governmental expenditures for public health activities

**Independent variables:**
- *Network characteristics*: network density, organizational degree centrality, betweenness centrality
- *Delivery system structure*: comprehensive, conventional, or limited public health delivery systems
Estimating delivery system effects

Statistical Model

- Log-transformed Generalized Linear Latent and Mixed Models
- Account for repeated measures and clustering of public health jurisdictions within states
- Instrumental variables address endogeneity of system structures

\[ \Pr(\text{System}_{z,ijt}=1) = \sum \alpha_z \text{Governance}_{ijt} + \beta_1 \text{Agency}_{ijt} + \beta_2 \text{Community}_{ijt} + \mu_j + \phi_t + \epsilon_{ijt} \]

\[ \ln(\text{Outcomes}|\text{Cost}_{ijt}) = \sum \alpha_z (\text{System}_z)_{ijt} + \beta_1 \text{Agency}_{ijt} + \beta_2 \text{Community}_{ijt} + \mu_j + \phi_t + \epsilon_{ijt} \]

All models control for type of jurisdiction, population size and density, metropolitan area designation, income per capita, unemployment, racial composition, age distribution, educational attainment, and physician availability.
Estimating delivery system effects: IV estimation

- Identify exogenous sources of variation in system activities that are unrelated to outcomes
  - Governance structures: local boards of health
  - Decision-making authority: agency, board, local, state

- Controls for unmeasured factors that jointly influence activities and outcomes
Variation in public health service delivery

National Longitudinal Survey of Public Health Systems

Percent of U.S. communities

Percent of activities performed
Delivery of recommended public health activities 1998-2014

- Assessment (+5.6%)
- Policy/Planning (+15.8%)
- Total (+1.1%)
- Assurance (-18.4%)
### Delivery of recommended public health activities

#### 1998-2014

<table>
<thead>
<tr>
<th>Public Health Activity</th>
<th>1998</th>
<th>2014</th>
<th>% Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Community health needs assessment</td>
<td>71.5%</td>
<td>86.0%</td>
<td>20.2%**</td>
</tr>
<tr>
<td>2 Behavioral risk factor surveillance</td>
<td>45.8%</td>
<td>70.2%</td>
<td>53.2%**</td>
</tr>
<tr>
<td>3 Adverse health events investigation</td>
<td>98.6%</td>
<td>100.0%</td>
<td>1.4%</td>
</tr>
<tr>
<td>4 Public health laboratory testing services</td>
<td>96.3%</td>
<td>96.5%</td>
<td>0.2%</td>
</tr>
<tr>
<td>5 Analysis of health status and health determinants</td>
<td>61.3%</td>
<td>72.8%</td>
<td>18.7%**</td>
</tr>
<tr>
<td>6 Analysis of preventive services utilization</td>
<td>28.4%</td>
<td>39.4%</td>
<td>38.8%**</td>
</tr>
<tr>
<td>7 Health information provision to elected officials</td>
<td>80.9%</td>
<td>84.8%</td>
<td>4.8%</td>
</tr>
<tr>
<td>8 Health information provision to the public</td>
<td>75.4%</td>
<td>83.8%</td>
<td>11.1%*</td>
</tr>
<tr>
<td>9 Health information provision to the media</td>
<td>75.2%</td>
<td>87.5%</td>
<td>16.3%**</td>
</tr>
<tr>
<td>10 Prioritization of community health needs</td>
<td>66.1%</td>
<td>82.3%</td>
<td>24.6%**</td>
</tr>
<tr>
<td>11 Community participation in health improvement planning</td>
<td>41.5%</td>
<td>67.7%</td>
<td>63.0%**</td>
</tr>
<tr>
<td>12 Development of community health improvement plan</td>
<td>81.9%</td>
<td>86.2%</td>
<td>5.2%</td>
</tr>
<tr>
<td>13 Resource allocation to implement community health plan</td>
<td>26.2%</td>
<td>43.2%</td>
<td>64.9%**</td>
</tr>
<tr>
<td>14 Policy development to implement community health plan</td>
<td>48.6%</td>
<td>57.5%</td>
<td>18.4%*</td>
</tr>
<tr>
<td>15 Communication network of health-related organizations</td>
<td>78.8%</td>
<td>84.8%</td>
<td>7.6%</td>
</tr>
<tr>
<td>16 Strategies to enhance access to needed health services</td>
<td>75.6%</td>
<td>50.2%</td>
<td>-33.6%**</td>
</tr>
<tr>
<td>17 Implementation of legally mandated public health activities</td>
<td>91.4%</td>
<td>92.4%</td>
<td>1.0%</td>
</tr>
<tr>
<td>18 Evaluation of public health programs and services</td>
<td>34.7%</td>
<td>38.4%</td>
<td>10.8%**</td>
</tr>
<tr>
<td>19 Evaluation of local public health agency capacity/performance</td>
<td>56.3%</td>
<td>55.0%</td>
<td>-2.4%</td>
</tr>
<tr>
<td>20 Implementation of quality improvement processes</td>
<td>47.3%</td>
<td>49.6%</td>
<td>5.0%</td>
</tr>
<tr>
<td>Composite availability of assessment activities (1-6)</td>
<td>66.7%</td>
<td>77.6%</td>
<td>16.4%**</td>
</tr>
<tr>
<td>Composite availability of policy development activities (7-15)</td>
<td>60.2%</td>
<td>72.5%</td>
<td>20.4%</td>
</tr>
<tr>
<td>Composite availability of assurance activities (16-20)</td>
<td>64.4%</td>
<td>52.8%</td>
<td>-18.0%*</td>
</tr>
<tr>
<td>Composite availability of all activities (1-20)</td>
<td>63.8%</td>
<td>67.6%</td>
<td>6.0%*</td>
</tr>
</tbody>
</table>
Equity in Delivery
Delivery of recommended public health activities, 2006-14

% of recommended activities performed

Quintiles of communities

Q1 Q2 Q3 Q4 Q5

2014

Δ 2006-14

-40% -20% 0% 20% 40% 60% 80% 100%
Changes in intensive and extensive margins during the Great Recession

### Organizational contributions to recommended public health activities, 1998-2014

<table>
<thead>
<tr>
<th>Type of Organization</th>
<th>1998</th>
<th>2006</th>
<th>2012</th>
<th>2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local public health agency</td>
<td>60.7%</td>
<td>66.5%</td>
<td>62.0%</td>
<td>67.4%</td>
</tr>
<tr>
<td>Other local govt agencies</td>
<td>31.8%</td>
<td>50.8%</td>
<td>26.3%</td>
<td>32.7%</td>
</tr>
<tr>
<td>State public health agency</td>
<td>46.0%</td>
<td>45.3%</td>
<td>36.4%</td>
<td>34.0%</td>
</tr>
<tr>
<td>Other state govt agencies</td>
<td>17.2%</td>
<td>16.4%</td>
<td>13.0%</td>
<td>12.7%</td>
</tr>
<tr>
<td>Federal agencies</td>
<td>7.0%</td>
<td>12.0%</td>
<td>8.7%</td>
<td>7.1%</td>
</tr>
<tr>
<td>Hospitals</td>
<td>37.3%</td>
<td>41.1%</td>
<td>39.3%</td>
<td>47.2%</td>
</tr>
<tr>
<td>Physician practices</td>
<td>20.2%</td>
<td>24.1%</td>
<td>19.5%</td>
<td>18.0%</td>
</tr>
<tr>
<td>Community health centers</td>
<td>12.4%</td>
<td>28.6%</td>
<td>26.9%</td>
<td>28.3%</td>
</tr>
<tr>
<td>Health insurers</td>
<td>8.6%</td>
<td>10.0%</td>
<td>9.8%</td>
<td>11.1%</td>
</tr>
<tr>
<td>Employers/business</td>
<td>25.5%</td>
<td>16.9%</td>
<td>13.4%</td>
<td>15.0%</td>
</tr>
<tr>
<td>Schools</td>
<td>30.7%</td>
<td>27.6%</td>
<td>24.9%</td>
<td>24.7%</td>
</tr>
<tr>
<td>Universities/colleges</td>
<td>15.6%</td>
<td>21.6%</td>
<td>21.2%</td>
<td>22.2%</td>
</tr>
<tr>
<td>Faith-based organizations</td>
<td>24.0%</td>
<td>19.2%</td>
<td>15.7%</td>
<td>16.8%</td>
</tr>
<tr>
<td>Other nonprofits</td>
<td>31.9%</td>
<td>34.2%</td>
<td>31.6%</td>
<td>33.6%</td>
</tr>
<tr>
<td>Other organizations</td>
<td>8.5%</td>
<td>8.8%</td>
<td>5.4%</td>
<td>5.4%</td>
</tr>
</tbody>
</table>
Bridging capital in public health delivery systems
Trends in betweenness centrality

* Change from prior years is statistically significant at p<0.05
Estimating health & economic impact: IV estimation

- Identify exogenous sources of variation in public health activities that are unrelated to outcomes
  - Governance structures: local boards of health
  - Decision-making authority: agency, board, local, state
- Controls for unmeasured factors that jointly influence activities and outcomes
## Determinants of Public Health System Comprehensiveness: Local IVs

<table>
<thead>
<tr>
<th>Governance/Decision Authority</th>
<th>Coefficient</th>
<th>95% CI</th>
<th>Elasticity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Governed by local board of health</td>
<td>0.131**</td>
<td>(0.061, 0.201)</td>
<td></td>
</tr>
<tr>
<td>State hires local PH agency head†</td>
<td>-0.151*</td>
<td>(-0.318, 0.018)</td>
<td></td>
</tr>
<tr>
<td>Local board approves local PH budget</td>
<td>0.388***</td>
<td>(0.576, 0.200)</td>
<td></td>
</tr>
<tr>
<td>State approves local PH budget†</td>
<td>-0.308**</td>
<td>(-0.162, -0.454)</td>
<td></td>
</tr>
<tr>
<td>Local govt sets local PH fees</td>
<td>0.217**</td>
<td>(0.101, 0.334)</td>
<td></td>
</tr>
<tr>
<td>Local govt imposes dedicated PH taxes</td>
<td>0.190**</td>
<td>(0.044, 0.337)</td>
<td></td>
</tr>
<tr>
<td>Local board can request local PH levy</td>
<td>0.120**</td>
<td>(0.246, 0.007)</td>
<td></td>
</tr>
</tbody>
</table>

\[ F=16.4 \ p<0.001 \]

log regression estimates controlling for community-level and state-level characteristics.  
*\( p<0.10 \)  **\( p<0.05 \)  ***\( p<0.01 \)

†As compared to the local board of health having the authority.

Mays et al. HSR 2009
Health and economic impact of comprehensive systems

Fixed Effects and IV Estimates: Effects of Comprehensive System Capital on Mortality and Spending

Models also control for racial composition, unemployment, health insurance coverage, educational attainment, age composition, and state and year fixed effects. N=779 community-years **p<0.05 *p<0.10
Making the case for equity: larger gains in low-resource communities

Effects of Comprehensive Public Health Systems in Low-Income vs. High-Income Communities

Log IV regression estimates controlling for community-level and state-level characteristics
Comprehensive systems do more with less

![Bar graph showing expenditures per capita and percentage of recommended activities performed for different types of delivery systems: Comprehensive, Conventional, Limited, Very limited.](image-url)
Conclusions

Comprehensive and highly-integrated public health systems appear to offer considerable health and economic benefits over time.

- 10-40% larger reductions in preventable mortality rates
- 15% lower public health resource use
- 6-9% lower medical costs

Low-income communities are less likely to achieve comprehensive public health system capital, as are communities without local governance structures.

But low-income communities benefit more from comprehensive systems where they exist

Failure to account for endogenous network structure can lead to biased estimates of impact
Strategies to improve population health and health system efficiency should include initiatives to build public health system capital.

Public health delivery has become increasingly reliant on nongovernmental & health care contributions.

Increased resiliency during economic shocks.

Heightened need for coordination, monitoring, and accountability.

Vulnerability to instability in contributions over time.
Next Steps

Ongoing and future studies:

- ACA impact
- Hospital community benefit activities
- PHAB accreditation
- Economic mobility and public health


New research program focuses on delivery and financing system alignment

http://www.systemsforaction.org
For More Information

Systems for Action
National Coordinating Center
Systems and Services Research to Build a Culture of Health

Supported by The Robert Wood Johnson Foundation

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