Using Systems Science to Optimize Health Security Coalitions and Networks: Applications with the National Health Security Preparedness Index

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Applications with the National Health Security Preparedness Index

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Health security requires collective actions across many activities and sectors

- Surveillance
- Environmental monitoring
- Laboratory testing
- Communication systems
- Response planning
- Incident management
- Emergency response
- Surge capacity
- Management & distribution of countermeasures
- Continuity of healthcare delivery
- Community engagement
- Workforce protection
- Volunteer management
- Education & training
- Drills & exercises
- Information exchange
- Evacuation & relocation
- Infrastructure resiliency
- Protections for vulnerable populations
Why a Health Security Index?

Track national progress in health security as a shared responsibility across sectors

- Raise public awareness
- Identify strengths and vulnerabilities
- Detect gains and losses
- Encourage coordination & collaboration
- Facilitate planning & policy development
- Support benchmarking & quality improvement
- Stimulate research & innovation
Networks as Force Multipliers

- Enhance coordination
- Accelerate information flow
- Acquire new ideas
- Spread innovations
- Build resilience

Background and Rationale

- Density
- Centralization
Key questions to explore with the Index

- How do health security levels vary across states and change over time?

- What roles do networks and coalitions play in shaping the dynamics of health security?
  - Healthcare Coalitions
  - Other community networks

- How can we strengthen coalitions & networks to improve overall health security?
Measurement: National Health Security Index

- 139 individual measures
- 19 subdomains
- 6 domains
- State overall values
- National overall values
- Normalized to 0-10 scale using min-max scaling to preserve distributions
- Imputations based on multivariate longitudinal models
- Empirical weights based on Delphi expert panels
- Bootstrapped confidence intervals reflect sampling and measurement error
- Annual estimates for 2013-2016

<table>
<thead>
<tr>
<th>Reliability by Domain</th>
<th>Alpha</th>
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</thead>
<tbody>
<tr>
<td>Health security surveillance</td>
<td>0.712</td>
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<td>Community planning &amp; engagement</td>
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<td>Incident &amp; information management</td>
<td>0.734</td>
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<tr>
<td>Healthcare delivery</td>
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</tr>
<tr>
<td>Countermeasure management</td>
<td>0.654</td>
</tr>
<tr>
<td>Environmental/occupational health</td>
<td>0.749</td>
</tr>
</tbody>
</table>
Methods & Data

Index measurement domains & subdomains

- Health Security Surveillance
  - Health Surveillance & Epidemiological Investigation
  - Biological Monitoring & Laboratory Testing

- Community Planning & Engagement
  - Cross-Sector / Community Collaboration

- Incident & Information Management
  - Incident Management & Multi-Agency Coordination
  - Emergency Public Information & Warning

- Healthcare Delivery
  - Prehospital Care
  - Inpatient Care

- Countermeasure Management
  - Medical Materiel Management, Distribution, & Dispensing
  - Countermeasure Utilization & Effectiveness

- Environmental & Occupational Health
  - Food & Water Security
  - Environmental Monitoring

- Social Capital & Cohesion

- Management of Volunteers during Emergencies

- Legal & Administrative

- Long-Term Care
  - Non-Pharmaceutical Intervention

- Mental & Behavioral Healthcare

- Home Care
Two Index measures capture network attributes

- Healthcare Coalition Membership Penetration
  - Local public health agencies
  - Local emergency management agencies
  - Hospitals
  - EMS agencies

- Comprehensiveness of Local Public Health Networks (Public Health System Capital)
  - Density
  - Centrality
Steady but slow progress

2017 Results

*statistically significant change
The U.S. improved in most domains during 2013-16, except healthcare delivery and environmental health.

*statistically significant change
Geographic disparities in health security are large and persistent
Changes vary widely across states and domains

<table>
<thead>
<tr>
<th>Category</th>
<th>Lowest State</th>
<th>US Average</th>
<th>Highest State</th>
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<tbody>
<tr>
<td>Health Security Surveillance</td>
<td></td>
<td>US +9.7%</td>
<td>VT +11.1%</td>
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<tr>
<td></td>
<td></td>
<td>CO +10.2%</td>
<td></td>
</tr>
<tr>
<td>Community Planning &amp; Engagement</td>
<td></td>
<td>US +16.0%</td>
<td>VT +32.1%</td>
</tr>
<tr>
<td></td>
<td>IA +5.3%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Incident &amp; Information Management</td>
<td></td>
<td>US +2.5%</td>
<td>VA +7.9%</td>
</tr>
<tr>
<td></td>
<td>HI –2.9%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Healthcare Delivery</td>
<td></td>
<td>US +3.9%</td>
<td>NH +0.0%</td>
</tr>
<tr>
<td></td>
<td>LA –2.9%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Countermeasure Management</td>
<td></td>
<td>US +7.7%</td>
<td>CO +8.0%</td>
</tr>
<tr>
<td></td>
<td>AK +7.5%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environmental &amp; Occupational Health</td>
<td></td>
<td>US –1.4%</td>
<td>VA +1.1%</td>
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<tr>
<td></td>
<td>OK –51.9%</td>
<td></td>
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</table>

Index Values in 2013 and 2016
Network drivers: density & penetration

Participation in Healthcare Preparedness Coalitions

2017 Results
Network drivers: density & centrality

Communities with Strong Multi-Sector Networks (Comprehensive Public Health System Capital)

*statistically significant difference
Unpacking public health system capital
One of RWJF’s Culture of Health National Metrics

- **Broad scope** of public health activities
- **Dense network** of multi-sector relationships
- **Central actors** to coordinate actions

### 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

Mapping public health system capital

Node size = degree centrality
Line size = % activities jointly contributed (tie strength)

Organizational contributions to system capital, 1998-2016

<table>
<thead>
<tr>
<th>Type of Organization</th>
<th>1998</th>
<th>2016</th>
<th>Percent Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local public health agencies</td>
<td>60.7%</td>
<td>67.5%</td>
<td>11.1%</td>
</tr>
<tr>
<td>Other local government agencies</td>
<td>31.8%</td>
<td>33.2%</td>
<td>4.4%</td>
</tr>
<tr>
<td>State public health agencies</td>
<td>46.0%</td>
<td>34.3%</td>
<td>-25.4%</td>
</tr>
<tr>
<td>Other state government agencies</td>
<td>17.2%</td>
<td>12.3%</td>
<td>-28.8%</td>
</tr>
<tr>
<td>Federal government agencies</td>
<td>7.0%</td>
<td>7.2%</td>
<td>3.7%</td>
</tr>
<tr>
<td>Hospitals</td>
<td>37.3%</td>
<td>46.6%</td>
<td>24.7%</td>
</tr>
<tr>
<td>Physician practices</td>
<td>20.2%</td>
<td>18.0%</td>
<td>-10.6%</td>
</tr>
<tr>
<td>Community health centers</td>
<td>12.4%</td>
<td>29.0%</td>
<td>134.6%</td>
</tr>
<tr>
<td>Health insurers</td>
<td>8.6%</td>
<td>10.6%</td>
<td>23.0%</td>
</tr>
<tr>
<td>Employers/businesses</td>
<td>16.9%</td>
<td>15.3%</td>
<td>-9.6%</td>
</tr>
<tr>
<td>Schools</td>
<td>30.7%</td>
<td>25.2%</td>
<td>-17.9%</td>
</tr>
<tr>
<td>Universities/colleges</td>
<td>15.6%</td>
<td>22.6%</td>
<td>44.7%</td>
</tr>
<tr>
<td>Faith-based organizations</td>
<td>19.2%</td>
<td>17.5%</td>
<td>-9.1%</td>
</tr>
<tr>
<td>Other nonprofit organizations</td>
<td>31.9%</td>
<td>32.5%</td>
<td>2.0%</td>
</tr>
<tr>
<td>Other</td>
<td>8.5%</td>
<td>5.2%</td>
<td>-38.4%</td>
</tr>
</tbody>
</table>
Health effects attributable to system capital

Impact of Comprehensive Systems on **Mortality**, 1998-2014

**Fixed-effects instrumental variables estimates controlling for racial composition, unemployment, health insurance coverage, educational attainment, age composition, and state and year fixed effects. N=1019 community-years**

Mays GP et al. *Health Affairs* 2016
Economic effects attributable to system capital

Impact of Comprehensive Systems on Medical Spending (Medicare) 1998-2014

Models also control for racial composition, unemployment, health insurance coverage, educational attainment, age composition, and state and year fixed effects. N=1019 community-years. Vertical lines are 95% confidence intervals

Mays GP et al. Health Services Research 2017
Economic effects attributable to system capital

Impact of Comprehensive Systems on Life Expectancy by Income (Chetty), 2001-2014

Models also control for racial composition, unemployment, health insurance coverage, educational attainment, age composition, and state and year fixed effects. N=1019 community-years. Vertical lines are 95% confidence intervals.
Conclusions & Implications

- Health security driven in part by the strength of networks:
  - Healthcare Coalitions
  - Multi-sector public health systems
- Network strength varies widely across communities & changes over time
- Networks have large health & economic implications for their communities

Discussion
Conclusions and implications

- Large health gains in places with strong system capital
- Larger gains for low-income populations
- Comprehensive systems do more than just plan: prioritize, invest, evaluate, repeat (crowd-sourcing)
- Equity and opportunity: more than half of communities currently lack comprehensive system capital
- ACA incentives and resources may help:
  - Hospital community benefit
  - Value-based health care payments
  - Insurer and employer incentives
- Sustainability and resiliency are not automatic
Caveats and cautions

- Imperfect measures & latent constructs
- Timing and accuracy of underlying data sources
- Unobserved within-state heterogeneity
- Short panel
- Observational, not causal, estimates
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