Estimating Indices of Health System Readiness in Northern Ghana

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Motivation

"For the first time, public health has commitment, resources, and powerful interventions. What is missing is this. The power of these interventions is not matched by the power of health systems to deliver them to those in greatest need, on an adequate scale, in time. This lack of capacity arises ... in part, from the fact that research on health systems has been so badly neglected and underfunded."

~ Dr Margaret Chan, Director-General, WHO. 29 October 2007
Health System Strengthening

WHO Building Blocks

- Leadership/Governance
- Service Delivery
- Human Resources
- Information
- Financing
- Medical Products, Vaccines, and Technologies

Overall goal: Improved Health (level and equity)

++ Perception of services

++ Coverage
++ Utilization
++ Quality

PEOPLE

RESPONSIVE
HSS: How do we measure it?

- Service Provision Assessments
- the problem -> too many indicators
Research Overview

- Research Question: Can we develop a single indicator of health system functioning that is ...  
- reliable?
- informative?
Principal Component Analysis (PCA)

- Common statistical technique for dimension reduction:

\[ z_{i1} = \phi_{11}x_{i1} + \phi_{21}x_{i2} + \ldots + \phi_{p1}x_{ip} \]

where,

\[
\arg\max \left\{ \frac{1}{n} \sum_{i=1}^{n} \left( \sum_{j=1}^{p} \phi_{j1}x_{ij} \right) \right\} \quad \text{subject to} \quad \sum_{j=1}^{p} \phi_{j1}^2 = 1.
\]

- Used to construct wealth indices from assets (Filmer & Pritchett)
PCA Example
PCA Example
PCA Example
Overview of the data set
Overview of the data set

- Facility census conducted in Upper East Region of Ghana in 2010
- Service provision assessment focused on maternal and newborn care
- 147 facilities (public and private)
## Overview of the data set

<table>
<thead>
<tr>
<th>Module</th>
<th>Title</th>
<th>Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Infrastructure</td>
<td>76</td>
</tr>
<tr>
<td>2</td>
<td>Human Resources</td>
<td>469</td>
</tr>
<tr>
<td>3</td>
<td>Drug, Equipment, and Supplies</td>
<td>594</td>
</tr>
<tr>
<td>4</td>
<td>Case Summary</td>
<td>1236</td>
</tr>
<tr>
<td>5</td>
<td>EmONC Signal Functions</td>
<td>217</td>
</tr>
<tr>
<td>6</td>
<td>Partograph Review</td>
<td>82</td>
</tr>
<tr>
<td>7</td>
<td>Provider Interview</td>
<td>194</td>
</tr>
<tr>
<td>8</td>
<td>Caesarean Section Review</td>
<td>98</td>
</tr>
<tr>
<td>9</td>
<td>Maternal Death Review</td>
<td>266</td>
</tr>
<tr>
<td>10</td>
<td>Neonatal Death Review</td>
<td>239</td>
</tr>
<tr>
<td>11</td>
<td>Emergency Referral</td>
<td>200</td>
</tr>
</tbody>
</table>
Index Development Procedure

1. Variable Selection
2. PCA
3. Testing/Validation
4. Health Impact
Variable Selection

Definition: Health system input = assets, resources, goods for service provision and performance.
Index Development Procedure

1. Variable Selection
2. PCA
3. Testing/Validation
4. Health Impact
PCA 2

![PCA Diagram](image-url)
<table>
<thead>
<tr>
<th>X</th>
<th>response</th>
<th>PC1.1</th>
<th>WHO_block</th>
<th>label</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>m11s3q14b</td>
<td>0.75</td>
<td>1</td>
<td>landline telephone</td>
</tr>
<tr>
<td>2</td>
<td>m1s3q8a</td>
<td>0.75</td>
<td>1</td>
<td>How many functional beds are in the store room?</td>
</tr>
<tr>
<td>3</td>
<td>m1s3q7</td>
<td>0.78</td>
<td>1</td>
<td>How many of the total number of beds are dedicated exclusively to obstetric patients?</td>
</tr>
<tr>
<td>4</td>
<td>m11s3q14a</td>
<td>0.85</td>
<td>1</td>
<td>Cell phone (owned by facility)</td>
</tr>
<tr>
<td>5</td>
<td>m5s1q1</td>
<td>0.87</td>
<td>1</td>
<td>Have antibiotics been administered parenterally in the last 3 months?</td>
</tr>
<tr>
<td>6</td>
<td>m2s1q5g8</td>
<td>0.73</td>
<td>2</td>
<td>Nurses work week nights?</td>
</tr>
<tr>
<td>7</td>
<td>m2s1q5g6</td>
<td>0.73</td>
<td>2</td>
<td>Nurses work Saturday and Sunday night?</td>
</tr>
<tr>
<td>8</td>
<td>m2s1q1n1</td>
<td>0.75</td>
<td>2</td>
<td>How many were posted at this facility in the last 12 months?</td>
</tr>
</tbody>
</table>
PCA 4
Index Development
Procedure

1. Variable Selection
2. PCA
3. Testing/Validation
4. Health Impact
Testing/Validation

- **Cesarean deliveries**
  - $R^2 = 0.342$

- **Elective/TOP/safe abortion**
  - $R^2 = 0.332$

- **Low birth weight**
  - $R^2 = 0.655$

- **New ANC registrants**
  - $R^2 = 0.3$

- **Stillbirths**
  - $R^2 = 0.621$

- **Vaginal delivery**
  - $R^2 = 0.569$
Index Development

Procedure

1. Variable Selection
2. PCA
3. Testing/Validation
4. Health Impact
Health Impact 1

Population Health Survey:

- 66 clusters by census enumeration area
- 5516 women of reproductive age
- retrospective survival cohorts for 8918 children born between Jan 1, 2000 and survey date (Apr - Sept 2011)
- child survival data matched to readiness of nearest community, sub-district, and district health facility
## Health Impact 2

Adjusted \(^a\) Cox Proportional Hazard model for under-5 mortality

<table>
<thead>
<tr>
<th></th>
<th>HR(^a)</th>
<th>95% CI</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CHPS readiness</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>1</td>
<td>ref</td>
<td>ref</td>
</tr>
<tr>
<td>High</td>
<td>1.1</td>
<td>(0.89, 1.36)</td>
<td>0.38</td>
</tr>
<tr>
<td><strong>HC readiness</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>1</td>
<td>ref</td>
<td>ref</td>
</tr>
<tr>
<td>Med</td>
<td>0.96</td>
<td>(0.72, 1.29)</td>
<td>0.8</td>
</tr>
<tr>
<td>High</td>
<td>1.09</td>
<td>(0.84, 1.41)</td>
<td>0.5</td>
</tr>
<tr>
<td><strong>Hospital readiness</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>1</td>
<td>ref</td>
<td>ref</td>
</tr>
<tr>
<td>Med</td>
<td>0.69</td>
<td>(0.48, 0.99)</td>
<td>0.04 *</td>
</tr>
<tr>
<td>High</td>
<td>0.65</td>
<td>(0.43, 0.98)</td>
<td>0.04 *</td>
</tr>
</tbody>
</table>

\(^a\) Adjusted for child sex, birth order, multiple birth, maternal age, parity, mother's education, religion, marital status, polygamy, household wealth, distance to CHPS, distance to HC, distance to hospital

*p < 0.05
Health Impact 3

![Survival over Time Graph]

- Survival is plotted on the y-axis, ranging from 0.00 to 1.00.
- Time is plotted on the x-axis, ranging from 0 to 4000.
- The graph shows four different survival curves, each represented by a different color.
Limitations

- Retrospective
- Readiness over time
Conclusion

- PCA can be used to construct an index of health system readiness
- A single component explains more than 30% of the common variance
- Some evidence that the indicator is associated with health outcomes
- More research need to establish causal link
Acknowledgements

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