Confronting the maze of disease transmission: Exploring the contribution of risks factors to disease in multiple exposure pathway settings

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Outline

- What is Risk Assessment?
- Are risk factors inter-related at different levels?
- How can the inter-relationships be explained and dis-entangled in terms of their contribution to disease in a risk assessment framework?
  - Case study from Ghana
- Conclusions
Risk assessment is the qualitative and quantitative characterisation and estimation of potential adverse health effects associated with exposure of individuals or populations to hazards.

**NO EXPOSURE----NO RISK OF DISEASE !!!!**

Haas *et al.* (1999)
Determines the size and nature of the exposed population and the pathways, amount and duration of exposure to the pathogenic organism
Central questions for exposure assessment

- **WHO** - defines exposed group
- **HOW MANY** - defines number of people (individuals) who are likely to be exposed directly or indirectly
- **WHERE** - defines where exposure occurs within the sanitation system
- **WHICH** - defines the routes to be considered
- **HOW** - defines the exposure frequency
- **WHAT** - defines the likely dose of exposure
Drivers of exposure to pathogenic organisms and vectors is the consequence of a number of risk factors:

- Socio-cultural
- Behaviour
- Perceptions
- Knowledge, attitude practices
- Economic
- Water and sanitation (Water Management)
- Hygiene practices
- Housing characteristics

There is an interplay of these risk factors at the individual, domestic and public domains in the pathway to diarrhoeal disease transmission.
Drivers of exposure

Money/Income → Diarrhoea
Drivers of exposure

Money/Income → Diarrhoea
Pit Latrine
Flush toilet

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Case Study: Faecal Sludge Application in Ghana
What is the contribution of faecal sludge application to diarrhoeal diseases in sludge applying households?
The domains of disease transmission

Public Domain
- Restaurants
- Solid waste disposal sites
- Public latrines

Domestic Domain
(Household level)
- Sludge farm (sludge drying times)
- Surface water
- School env’t
- Institutional environment
- Domestic animals
- Roofing material/room occupancy rate
- Floor material
- Pets
- Water management

Individual Domain
- Age
- Religion
- Gender
- Practices (handwashing etc)
- Educational level
- Behaviour
- Knowledge

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Multivariate Intra-block analyses of Potential Risk Factors Associated with Diarrhoeal Disease in Sludge applying households in the Tamale Metropolitan Area, Ghana (N=1341)

BLOCK I: Distal

Socio-Economic
a. Wealth status b. Mother Literacy c. Father Literacy d. Housing type

BLOCK II: Public Domain

Sanitation Infrastructure
a. toilet facility b. garbage dump nearby

Water Infrastructure
a. Drinking water source c. distance covered to fetch water

Faecal Sludge application
b. Sludge drying time

BLOCK III: Domestic Domain

Water Hygiene
a. water storage container b. treat drinking water

Food Hygiene
a. eat outside b. food storage c. cover food during storage d. cleaning of utensils used for food preparation

Personal Hygiene
a. Soap use among children b. Bathing with soap c. hand wash with soap after toilet d. protective cloth

Household Hygiene
a. animals in house b. pets in house c. refuse in house d. faeces in house

Contact
a. room occupancy rate b. cemented floor

Diarrhoea Incidence
Disentangling the risk factors

- Multivariate INTRA-BLOCK and INTER-BLOCK mixed Poisson regression was run based on the conceptual framework of diarrhoeal disease transmission routes

- Model A: Distal Socio-economic factors

- Model B: Distal socio-economic factors + public domain

- Model C: Distal socio-economic factors + public domain + domestic domain
Population Attributable Fractions of Diarrhoeal Disease for blocks of Risk Factors based on reduced Inter-block Mixed Effect Poisson Regression Models (N=1431)

<table>
<thead>
<tr>
<th>BLOCK I: DISTAL FACTORS</th>
<th>(%)</th>
<th>RR (95% CI)</th>
<th>PAF</th>
<th>PAFT&lt;sup&gt;b&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wealth status</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>18.33</td>
<td>1.18 (0.94 – 1.49)</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td>29.56</td>
<td>1.19 (0.92 – 1.53)</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>52.11</td>
<td>1.19 (0.92 – 1.53)</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>BLOCK II: PUBLIC DOMAIN</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Distance covered to fetch water</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥ 500 m</td>
<td>47.61</td>
<td>1.63 (1.43 – 1.85)</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>≤ 500 m</td>
<td>52.39</td>
<td>1.04 (0.69 – 2.01)</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Faecal Sludge Application (after x days of drying)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤ 14</td>
<td>46.68</td>
<td>1.28 (1.04 – 1.59)</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>21 – 30</td>
<td>21.55</td>
<td>1.19 (0.72 – 1.98)</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>60</td>
<td>11.63</td>
<td>1.04 (0.69 – 2.01)</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>≥ 90</td>
<td>20.13</td>
<td>1.04 (0.69 – 2.01)</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>BLOCK III: DOMESTIC DOMAIN</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Handwashing with soap after toilet</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>50.71</td>
<td>1.36 (1.13 – 1.65)</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>49.29</td>
<td>1.36 (1.13 – 1.65)</td>
<td>18</td>
<td></td>
</tr>
</tbody>
</table>

<sup>b</sup> sum of PAFs of significant variables
Multivariate Intra-block analyses of Potential Risk Factors Associated with Diarrhoeal Disease in Sludge applying households in the Tamale Metropolitan Area, Ghana (N=1341)

BLOCK I: Distal (86% mediated by public and domestic domain)

Socio-Economic
- a. Wealth status
- b. Mother Literacy
- c. Father Literacy
- d. Housing type

33%

BLOCK II: Public Domain

Sanitation Infrastructure
- a. toilet facility
- b. garbage dump nearby

Water Infrastructure
- a. Drinking water source
- c. distance covered to fetch water

Faecal Sludge application
- b. Sludge drying time

53%

BLOCK III: Domestic Domain

Water Hygiene
- a. water storage container
- b. treat drinking water

Food Hygiene
- a. eat outside
- b. food storage
- c. cover food during storage
- d. cleaning of utensils used for food preparation

Personal Hygiene
- a. Soap use among children
- b. Bathing with soap
- c. hand wash with soap after toilet
- d. protective cloth

Household Hygiene
- a. animals in house
- b. pets
- c. refuse in house
- d. faeces in house

Contact
- a. room occupancy rate
- b. cemented floor

70%

70%

Diarrhoea Incidence

14%
Conclusions

- Risk assessment should be addressed from a system perspective
  - All levels (individual, domestic and public domain risk factors) and their inter-relationship have to be accounted for.
  - An understanding of the inter-relationship between different risk factors in the exposure pathway to disease transmission is critical for the development of effective interventions.

Thanks