Predictors and Health Outcomes of Water Insecurity After a Flood Among an Indigenous Population in the Bolivian Amazon

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Introduction

- An urgent need exists to understand and address water insecurity as 763 million people lack access to safe drinking water (Wulff & Brolin 2014).
- "Water insecurity" is defined as "insufficient and uncertain access to adequate water for an active and healthy lifestyle" (Hagley & Wulff 2006; Stevenson et al. 2012).
- Indigenous populations in developing countries are often the most vulnerable to natural disasters because of socioeconomic disparities (Few 2003).
- In particular, flooding poses substantive stress on water systems and can disrupt many aspects of life and health (Ahern & Kovats 2013).
- Yet, little is known about how flooding contributes to water insecurity and health during rapid local transitions among indigenous populations.

In this paper, I assess the predictors of water insecurity following a flood and, in turn, the risks of diarrhea and dehydration among two indigenous villages at different stages of market integration.

Study Area: Beni, Bolivia

- Campo Seco (Market integrated villages): 1 hour by car from San Diem in the dry season or 2 days by motorcycle in the rainy season.
- Avasare: (Traditional villages): 2 days by motorcycle in the rainy season.

Methods

- 15,000 Timanera live in ~100 villages: Data come from an observational study in two Timana villages during March-April, 2014 following a historically devastating flood.
- Interviews and anthropometric measurements using exhaustive sampling.
- Water insecurity was a locally-adapted 9 question index addressing the three dimensions of water insecurity in the past month: access, adequacy, and lifestyle (Stevenson et al. 2012). Yes (Sometimes and always) = 1; No (or rarely) = 0.
- Categorical variable: Low water insecurity (WI): 1.5; Medium WI: 4.8; High WI: 7.6 Health recall 7 days coupled with doctor examinations. Diarrhea was defined as 0 or more bouts of diarrhea in any 24 hour period.
- Hydration levels: Urine samples collected. Urine specific gravity measured with refractometer (Atago) Urine: Dehydration cutoff level = 1.020 g/mL.
- To assess water quality, we used the Hach Protascreen field kit. The Protascreen™ Medium detects the presence of hydrogen sulfide-producing bacteria incl. Salmonella, Shigella, Proteus, Edwardsiella, and Klebsiella. Indigenous E. coli does not interfere with the Protascreen test, which makes it an excellent alternative to coliform testing.
- Analysis was conducted in Stata 13.0. Used OLS multivariate logistic and linear regression to estimate models and the adjusted predicted probabilities to visualize effects.

Data

- Water Insecurity Index

<table>
<thead>
<tr>
<th>Water Insecurity Question</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Have you been stuck getting water to cook or clean in the last month?</td>
<td>15%</td>
<td>85%</td>
</tr>
<tr>
<td>2) Have you been thirsty because there wasn’t enough water to drink?</td>
<td>13%</td>
<td>87%</td>
</tr>
<tr>
<td>3) Have you been worried about the quality of your water?</td>
<td>16%</td>
<td>84%</td>
</tr>
<tr>
<td>4) Have you had your house flooded because of too much rain?</td>
<td>16%</td>
<td>84%</td>
</tr>
<tr>
<td>5) Have you or your family died because of too much rain?</td>
<td>97%</td>
<td>3%</td>
</tr>
<tr>
<td>6) Have you been unable to get enough water to make ditches (social traditional behaviors)</td>
<td>15%</td>
<td>85%</td>
</tr>
<tr>
<td>7) Have you changed water sources from your primary source because that water was dirty?</td>
<td>60%</td>
<td>40%</td>
</tr>
<tr>
<td>8) Have you had someone in your family been sick because your water was dirty?</td>
<td>77%</td>
<td>23%</td>
</tr>
<tr>
<td>9) Have you been worried that your children would get sick because your water was dirty?</td>
<td>16%</td>
<td>84%</td>
</tr>
</tbody>
</table>

- Water Sources, Quality Assessment, and Insecurity by community

<table>
<thead>
<tr>
<th>Village</th>
<th>Water Source</th>
<th>using</th>
<th>Total Drink (mg/L)</th>
<th>Bacteria</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>River (WI: 4.5)</td>
<td>143</td>
<td>7.2</td>
<td>58.3</td>
</tr>
<tr>
<td></td>
<td>Market Stream (WI: 3.7)</td>
<td>--</td>
<td>--</td>
<td>3.5</td>
</tr>
<tr>
<td></td>
<td>Integrated Well (WI: 3.0)</td>
<td>4</td>
<td>7.3</td>
<td>164.7</td>
</tr>
<tr>
<td></td>
<td>Village Pump (WI: 3.5)</td>
<td>38</td>
<td>7.5</td>
<td>115.8</td>
</tr>
<tr>
<td></td>
<td>Pond (WI: 3.5)</td>
<td>11</td>
<td>15.0</td>
<td></td>
</tr>
</tbody>
</table>

- Traditional Water (WI: 4.5) | 190 | 9.5 | 28.3 |

- Water Security: Medium (WI: 4.8) | 250 | 9.5 | 47.3 |

Water Quality: Integrated (WI: 3.0) | 250 | 11.5 | 43.3 |

- No: Number; UTU: Unthrombomicrobiological; Oxi: Dissolved oxygen; ppm: parts per million; Pathy: Pathogen

- Water Security: Low (WI: 1.5) | 190 | 9.5 | 28.3 |

- Water Security: High (WI: 7.5) | 250 | 9.5 | 47.3 |

Results: Water Security and Dehydration

Logistic regression and marginal plots of maternal water insecurity on odds of being dehydrated for children

- Logistic regression: Maternal water insecurity is a social demographic variable

- Probability of dehydration: 44% and 44% among children whose mothers report Medium and High Water Insecurity, respectively, while only 1% among children whose mothers had Low Water Insecurity.

Discussion and Conclusion

- Predictors of water insecurity relate to available water sources in the villages, market integration, and age. Individuals using hand pumps, the cleaned source, had the lowest water insecurity.
- Public health interventions may increase awareness that raw water sources are dirty.
- These messages may be reaching younger adults, especially in the more market integrated village where water-treatment posters are visible in the village school.
- Water insecurity for adults matches onto probability of diarrhea for adults, while maternal water insecurity predicts probability of dehydration for their children.
- Flooding affects multiple dimensions of water insecurity.
- Water insecurity assessment is important for public health flood responses to consider as it reflects perceptions of stress related to water and can predict important water-related morbidities.

Acknowledgements

- Thank you to the Timana participants & the Timana Grand Council. This research was supported by a Dissertation Writing Grant from the Werner-Goren Foundation (2012) and the National Science Foundation (DTH-1314116). (IRI 1221/1202019).

References