Association of Floods and Child Malnutrition in Rural Eastern India
A Population-Based Survey

Jose M. Rodriguez-Llanes,*, Shisir Ranjan-Dash, Laura Irvine, Alok Mukhopadhyay, Debarati Guha-Sapir

* Corresponding author: jose.rodriguez@uclouvain.be

Centre for Research on the Epidemiology of Disasters, Université catholique de Louvain, Brussels, Belgium
Voluntary Health Association of India, New Delhi, India.
Background

Flood events in rural Asia

• Floods are the most common reported natural disaster worldwide \(^1\) with important impact on health of human populations \(^2\)

• Their frequency and impacts are especially dramatic in developing countries of south and south-east Asia \(^3\)

• Flood events produce serious impacts on rural areas, such as crop lost or reduction of crop productivity, \(^4\) and farmers are likely to be hardly affected by increased climatic variability under climate change predictions. \(^5\)

Background

Limited knowledge of the links between floods and health

• Scant evidence on the health effects of floods in controlled epidemiological studies, particularly of morbidity

• Some studies on mortality, disease or mental health but little research on the association between floods and children’s nutritional health.

Background

Impacts of malnutrition on child health

• Undernutrition is a primary cause of ill-health and premature mortality among children in developing countries. ¹⁰

• Malnutrition affects children during critical phases of their early cognitive, social, motor and emotional development, and is associated with poor school performance. ¹¹, ¹²

Background
Focus on India

• According to historical EM-DAT data on floods, India is the second country in the world in number of persons affected by floods \textsuperscript{1}

• The eastern Indian state of Orissa is vulnerable to multiple disasters, such as tropical cyclones, storm surges and tsunamis

• Jagatsinghpur, a coastal district of the state of Orissa, eastern India suffered the ferocities of cyclone Paradip in 1999 and floods in 2001, 2003, 2006 and 2008

\textsuperscript{1} EM-DAT: The OFDA/CRED International Disaster Database
Background

Study area
Study objectives

1. Estimate the prevalence of malnutrition in two subpopulations of children, those living in 123 villages inundated by the last floods occurring in September 2008 and those living in the 142 nearby, but non-flooded, villages.

2. Assess the size and robustness of the association between flood exposure and malnutrition by testing the possible confounding effects of socioeconomic variables.
Methods

Data collection: Anthropometry

- Three anthropometric indicators to assess malnutrition in children aged 6 to 59 months (WHO standard):

1. **Wasting** or acute malnutrition as weight-for-height (WFH)

2. **Stunting** or chronic, as height-for-age (HFA)

3. **Underweight** (chronic and acute) as weight-for-age (WFA)
Methods

Data collection: Anthropometry

![Weight-for-Height z-scores](image)

- **a** Flooded
- **b** Non-flooded
Methods

Data collection: Interviews

• Face-to-face interviews to collect background variables

  – Age, sex and birth weight of the children
  – Household size and income
  – Education level of mother and father
  – Occupation of mother and father
  – Religion and caste
  – More, but not used here....
Methods

Data collection: Population Information

**List of flooded and non-flooded villages**

- **Orissa State Disaster Mitigation Authority, OSDMA**

**Village size and total population of children**

- **Census of India 2001**

**List of children in the selected village**

- **ICDS centers and village ward members**
Methods

Study Design: Sample size requirements

• The required sample for estimating a 50% prevalence with a 5% error was **870** (population size= **20000**)
  
  – Design effect (Deff) = 2 (conservative)
  
  – Population size uncertainty considered: up to **40 000 (878)**

• **Sample size** required to detect a 15% difference (with a 80% Power) in prevalence of malnutrition in flooded and non-flooded children subpopulations was **682**
  
  – Same sample size in both groups
  
  – Worst scenario (50% vs 35% prevalence)
Methods

Study Design: Sample

- **Two-stage cluster design**
  - first stage (villages) **PPS sampling**
  - second stage (children) **SRS**

- **12 children** died and **9 absent**

- The AAPOR minimum **response rate** was **98.9%**

- **10 observations** out of the age range;
  - **2 more records** not included in wasting

- **Analysis**: **ENA and R software**

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**Figure**: Flow Diagram of Sample From Children aged 6 to 59 months in Rural Kujang, Biridi, Balikuda, Tirtol Blocks in Jagatsinghpur District, State of Orissa, India.
Results

Estimates of malnutrition in flooded and non-flooded areas

• The prevalence of wasting
  – **48.7** (95% CI 43.2-54.2) in the flooded subpopulation
  – **16.5** (95% CI 13.7-19.3) in the non-flooded.

• The prevalence of **stunting** was **similar** among both subpopulations

• **Underweight** showed similarities with wasting but smaller in size
Table 1. Prevalence of Wasting, Underweight and Stunting Among Children Aged 6 to 59 Months, Flooded and Non-Flooded Rural Areas of Jagatsinghpur District, India

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No. (%; 95% Confidence Interval)

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Results

Do malnutrition indicators differ across sex or age?

• Prevalence of wasting, stunting and underweight were similar across sex

• Youngest group of children (6-18 months) was at higher risk of being wasted than others, a priori independently of whether or not they were directly exposed to floods.
**Table 2. Malnutrition by Sex and Age in Children 6 to 59 Months, Flooded and Non Flooded Rural Areas of Jagatsinghpur District, India**

<table>
<thead>
<tr>
<th>Sex</th>
<th>Wasting*, %, 95% CI (n)</th>
<th>Stunting, %, 95% CI (n)</th>
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<td>Age, mo</td>
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<tr>
<td>&gt;6-18</td>
<td>58.7 (92)</td>
<td>29.1 (110)</td>
<td>18.5 (92)</td>
</tr>
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<td>&gt;18-30</td>
<td>38.9 (90)</td>
<td>12.6 (95)</td>
<td>26.7 (90)</td>
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<td>&gt;30-42</td>
<td>42.1 (95)</td>
<td>6.0 (84)</td>
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<td>&gt;42-54</td>
<td>52.5 (101)</td>
<td>16.3 (92)</td>
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<td>&gt;54-60</td>
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Results
What is the association size?

• The chance of being wasted 12 months after the September 2008 floods was three times higher for children (6-59 months) living in inundated villages compared to non-flooded, even after adjusting for possible confounding variables such as sex, age and birth weight of the children, and education, religion, caste, income and size of family.

• Stunting did not show any pattern, even when adjusting by previous variables.

• Risk of being underweight was around 60% higher in the exposed subpopulation after adjusting for socio-economic variables.
Table 3. Crude and Adjusted Association of Direct Exposure to Flooding With Prevalence of Malnutrition in Children Aged 6 to 59 Months, Jagatsinghpur District, India (n=869)\textsuperscript{a}

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Abbreviations: CI, confidence interval; PR, prevalence ratio.

\textsuperscript{a}879 children measured and weighted and their families interviewed; 8 observations our of age range 6 to 59 months and 2 incorrect ages removed; ENA software was unable to calculate 2 additional \textit{z} scores for wasting, thus the final sample size for wasting is 867. Adjusted PR are adjusted by children sex, age, weight at birth, family income, household size, mother education level, father education level, and cast and religion at the household level.

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Discussion

• Wasting was the best indicator of child nutritional stress one year after floods, and indicates an acute malnutrition problem.

• Wasting was already above the recommended threshold of 15% in the non-flooded area!!

• 48.7% of approx. 9025 children were wasted in the 123 flooded (reassessment needed)
Discussion

- Previous non population-based study conducted 2-3 months after the same flood showed differences in stunting (probably long-lasting effect of previous floods) between children in flooded and non-flooded villages. Wasting remained below 15%.

- Results suggest that relief provided by NGO and government might be enough to avoid high indices of malnutrition during only the immediate months after flooding.
Recommendations

• Medium-term support programs are necessary to protect these communities of the nutritional impacts of disasters on children.

• This support should last for at least one year (the minimum).

• More research is needed to understand the dynamics of malnutrition in a post-flooding scenarios (a smaller assessment 24 months later).

• These dynamics needs to be understood to implement adequate and efficient response to disasters in the future.
• Acknowledgement:

MICRODIS consortium for development of tools and conceptual models

The VHAI research assistants for data collection.

This research in the MICRODIS Integrated Project was funded by the European Commission’s 6th Framework Programme. www.microdis.eu.be

THANK YOU!!