Emerging Evidence on Health and Food Safety and Effects on the Growth and Development of Infants and Young Children

Looking Beyond a Decade of Accomplishments in Nutrition
NIL Legacy Event | September 17th, 2021

Christopher Duggan  Jacqueline Lauer  Akriti Singh  Johanna Andrews-Trevino  Saiful Islam
Environmental Enteric Dysfunction and Undernutrition: New Insights and Ongoing Challenges

Jacqueline M. Lauer, PhD, MPH
ENVIRONMENTAL ENTERIC DYSFUNCTION

Nutrient Malabsorption
Increased Nutrient Requirements
Growth Hormone Resistance
Biomarkers of maternal environmental enteric dysfunction are associated with shorter gestation and reduced length in newborn infants in Uganda

Jacqueline M Lauer, Christopher P Duggan, Lynne M Ausman, Jeffrey K Griffiths, Patrick Webb, Edgar Agaba, Nathan Nshakira, Hao Q Tran, Andrew T Gewirtz, Shibani Ghosh
EED INTERVENTIONS

6 CLEAN WATER AND SANITATION

MICRONUTRIENT POWDER
Food fortification of complementary foods for children and vulnerable populations to address anaemia and vitamin & mineral deficiencies.


Emerging Biomarkers of Environmental Enteric Dysfunction (EED)
MEASURING EED

• Several emerging biomarkers
  – Host fecal mRNA transcripts
  – Fecal proteins
  – Microbiota

• EED and MAM
  – Growth
  – Treatment outcomes
  – Household WASH conditions

Adapted from Prendergast et al. 2015
NIL-SUPPORTED STUDIES

• EED and growth
  – mRNA-based score (inflammation) inversely associated with LAZ and WLZ

• EED and recovery from MAM
  – mRNA-based score (gut defense) directly associated with recovery
  – Protein AAT (permeability) inversely associated with recovery
NIL-SUPPORTED STUDIES

• EED and Microbiota
  – High mRNA-based score (inflammation) enriched in inflammogenic taxa

• EED and household WASH conditions
  – Improved drinking water source directly associated with lower intestinal permeability (mRNA-based score, LMER, AAT)

Source: Singh 2020


Exposure to Multiple Mycotoxins, Environmental Enteric Dysfunction and Child Growth in Banke, Nepal

Johanna Andrews Trevino, PhD, MSc
Main objective: Understand the relationship of *in utero* and early life exposure to aflatoxin and linear growth in the first 24 months of life, controlling for other potential explanatory factors.
SURVEY DATA & BIOMARKER COLLECTION
### SERUM AFLATOXIN CONCENTRATIONS

<table>
<thead>
<tr>
<th>Age Group</th>
<th>n</th>
<th>Detectable Aflatoxin B1 (%)</th>
<th>Mean ± SD AFB1 (pg/mg alb)</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pregnancy</td>
<td>1652</td>
<td>94.3</td>
<td>3.4 ± 8.5</td>
<td>0.4</td>
<td>147.3</td>
</tr>
<tr>
<td>Child 3 mo</td>
<td>1363</td>
<td>80.5</td>
<td>1.0 ± 1.1</td>
<td>0.4</td>
<td>24.7</td>
</tr>
<tr>
<td>Child 6 mo</td>
<td>1294</td>
<td>75.3</td>
<td>1.2 ± 2.1</td>
<td>0.4</td>
<td>41.6</td>
</tr>
<tr>
<td>Child 12 mo</td>
<td>1329</td>
<td>81.1</td>
<td>2.0 ± 4.6</td>
<td>0.4</td>
<td>84.6</td>
</tr>
<tr>
<td>Child 18-22 mo</td>
<td>699</td>
<td>85.1</td>
<td>2.4 ± 7.9</td>
<td>0.4</td>
<td>128.1</td>
</tr>
</tbody>
</table>

- **High occurrence of aflatoxin exposure during pregnancy.**
- **High occurrence of aflatoxin exposure in the first 2 years of life.**
Relatively Low Maternal Aflatoxin Exposure Is Associated with Small-for-Gestational-Age but Not with Other Birth Outcomes in a Prospective Birth Cohort Study of Nepalese Infants

Johanna Y Andrews-Trevino,1 Patrick Webb,4 Gerald Shively,2 Beatrice L. Rogers,1 Kedar Baral,3 Dale Davis,4 Krishna Paudel,1 Ashish Pokharel,1 Robin Shrestha,1 Jia-Sheng Wang,8 and Shibani Ghosh1

1Friedman School of Nutrition Science and Policy, Tufts University, Boston, MA, USA; 2Department of Agricultural Economics, Purdue University, West Lafayette, IN, USA; 3Department of Community Health Sciences, Patan Academy of Health Sciences, Lalitpur, Nepal; 4Helen Keller International-Nepal, Kathmandu, Nepal; 5Kanti Children’s Hospital, Kathmandu, Nepal; and 6Department of Environmental Health Science, University of Georgia, Athens, GA, USA

20% low birth weight
38% small-for-gestational age
16% Stunting at birth
Stunting
Birth: 15%
12 mo: 27%
18 and 24 mo: 40%

Source: Mycotoxin Birth Cohort Study / Banke, Nepal / 2015-2019
### AFLATOXINS & GROWTH OUTCOMES

<table>
<thead>
<tr>
<th></th>
<th>Length (cm)</th>
<th>LAZ</th>
<th>Stunting</th>
<th>Knee-heel length (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>β</td>
<td>95% CI</td>
<td>P</td>
<td>β</td>
</tr>
<tr>
<td>AFB₁</td>
<td>-0.19</td>
<td>-0.29, -0.10</td>
<td>&lt;0.001</td>
<td>-0.05</td>
</tr>
<tr>
<td>AFB₁/weight (kg)</td>
<td>-0.26</td>
<td>-0.33, -0.18</td>
<td>&lt;0.001</td>
<td>-0.08</td>
</tr>
</tbody>
</table>

Changes in child AFB1-lysine adduct concentrations were significantly associated with changes in LAZ, length, and knee-heel length.

Serum aflatoxin concentrations were associated with higher odds of stunting.
## MYCOTOXIN CONCENTRATIONS

<table>
<thead>
<tr>
<th></th>
<th>n</th>
<th>n (%) detectable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ochratoxin A, ng/mL</td>
<td>699</td>
<td>699 (100)</td>
</tr>
<tr>
<td>Fumonisin B1, pg/mg creatinine</td>
<td>683</td>
<td>683 (100)</td>
</tr>
<tr>
<td>Deoxynivalenol, ng/mg creatinine</td>
<td>689</td>
<td>596 (87)</td>
</tr>
</tbody>
</table>

High occurrence of mycotoxin exposure at 18-22 months of age.
### MYCOTOXINS, EED & GROWTH OUTCOMES

<table>
<thead>
<tr>
<th></th>
<th>Length, cm</th>
<th>Weight, kg</th>
<th>Head circumference, cm</th>
<th>Stunting, %</th>
<th>Underweight, %</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Aflatoxin B1, pg/mg albumin</strong></td>
<td>-0.29 (-0.53, -0.05)</td>
<td>-0.11 (-0.18, -0.03)</td>
<td>-0.08 (-0.15, -0.004)</td>
<td>1.29 (1.10, 1.50)</td>
<td>1.20 (1.03, 1.40)</td>
</tr>
<tr>
<td><strong>Ochratoxin A, ng/mL</strong></td>
<td>0.15 (-0.23, 0.54)</td>
<td>0.10 (-0.05, 0.25)</td>
<td>0.04 (-0.08, 0.16)</td>
<td>0.98 (0.80, 1.19)</td>
<td>0.88 (0.67, 1.15)</td>
</tr>
<tr>
<td><strong>Fumonisin B1, pg/mg creatinine</strong></td>
<td>-0.07 (-0.22, 0.09)</td>
<td>-0.02 (-0.07, 0.03)</td>
<td>0.03 (-0.02, 0.08)</td>
<td>1.05 (0.94, 1.18)</td>
<td>1.09 (1.00, 1.18)</td>
</tr>
<tr>
<td><strong>Deoxynivalenol, ng/mg creatinine</strong></td>
<td>0.11 (-0.03, 0.26)</td>
<td>0.05 (-0.02, 0.11)</td>
<td>-0.05 (-0.10, -0.002)</td>
<td>0.95 (0.84, 1.06)</td>
<td>0.95 (0.84, 1.08)</td>
</tr>
<tr>
<td><strong>L:M ratio</strong></td>
<td>-0.33 (-0.63, -0.03)</td>
<td>-0.11 (-0.21, -0.02)</td>
<td>-0.04 (-0.15, 0.07)</td>
<td>1.19 (0.92, 1.55)</td>
<td>1.02 (0.78, 1.33)</td>
</tr>
</tbody>
</table>

While exposure to multiple mycotoxins is common, we found a more consistent relationship between higher AFB1-lysine adduct levels and child growth outcomes.
KEY TAKEAWAYS

• We found widespread exposure to mycotoxins in the first 1000 days.

• Findings add to the body of evidence hypothesizing that aflatoxin may be a contributor to poor child growth. Interventions to reduce dietary exposure to aflatoxin may have positive effects on child growth in LMICs.

• Weight (and age)-varying effects are an emerging priority issue requiring deeper research-based understanding.

• Food systems approach to food safety – exposure comes from a variety of sources. There are various exposure channels to consider beyond the household (e.g. markets, trade, exchanges) [data not shown].

• Effective research requires a rigorous design and partnerships rooted in mutual respect and good communication.
COLLABORATORS AND TEAM

- USAID Bureau of Resilience and Food Security and USAID Nepal
- Child Health Division, Department of Health Services, MOHP
- Nepal Health Research Council (NHRC) and Tufts IRB
- Patan Academy of Health Sciences (PAHS)
- Helen Keller International (HKI) - Nepal
- Purdue University
- University of Georgia/FTF Innovation Lab on Peanuts and Mycotoxins
- Kansas State/FTF Innovation Lab for the Reduction of Post-Harvest Loss
- Banke District Public Health Office
- Banke VDC and Ward Health Posts, FCHVs
- Nepalgunj Medical College
- AflaCohort Field team and participants
Unpacking the Determinants of Food Safety and Quality Concern Dynamics: Evidence Using Panel Data from Rural Bangladesh

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BACKGROUND

- With the change in:
  - agri-food system;
  - increase in income and;
  - improvement of living standards,
- Consumers have become increasingly concerned about food quality and safety, nutrition, health and wellbeing (Botonaki et al., 2006; WHO, 2015).
Consumers concern on food safety and quality in two rounds

**Round 1**

- **Meat**: Concern 438, Not Concern 1,252
- **Dairy**: Concern 341, Not Concern 1,202
- **Fish**: Concern 1,060, Not Concern 993
- **Fruits**: Concern 629, Not Concern 1,438
- **Vegetables**: Concern 1,038, Not Concern 1,993

**Round 2**

- **Meat**: Concern 606, Not Concern 838
- **Dairy**: Concern 339, Not Concern 838
- **Fish**: Concern 1,333, Not Concern 1,111
- **Fruits**: Concern 1,038, Not Concern 900
- **Vegetables**: Concern 1,706, Not Concern 1,181
Dynamics of consumers’ food safety and quality concern behavior

Round 1

Concern on food safety and quality
N=1396

Not concern on food safety and quality
N=1553

Round 2

Concern on food safety and quality=continuously concern
N= 971

Not concern on food safety and quality = Not concern anymore
N= 425

Concern on food safety and quality = Newly concern
N= 1095

Not concern on food safety and quality = Never concern
N= 458
Reason for concerns and coping strategies against concerns

Reason for concern on food safety and quality

Coping strategies against food safety and quality
Determinants of Food Safety and Quality Concern

Concern about food safety and quality are more among:

✓ male headed; higher educated;
✓ Comparatively richer;
✓ who have access to electricity;
✓ located long distant from the market; and
✓ who purchased more number of food items.

❑ Temporal (location) and spatial (round/season) disparities exist.
❖ Own production of high value foods particularly fish and fruit production reduces worry about food safety and quality.
CONCLUSIONS

• Consumers are not confident about the safety and quality of foods items they purchased for various reasons.

• Food safety and quality in the developing countries not only an exports phenomenon.

• Own production diversity reduces food safety and quality concern.

• Finally, better management of insect, pest and diseases and chemical inputs and promoting alternative safe measures such as integrated pest management (IPM), and overall food environment improvement would substantially reduce consumers’ worries about food safety and quality.
Q&A