LNS & RUSF in transdisciplinary nutrition programming: the Haiti experience

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Presentation outline

1) Introduction: Transdisciplinary Nutrition
   a.) WHO Framework for Stunted Growth & Development

2) LNS & RUSF: Research in Haiti
   a.) Nutributter: complementary food security
   b.) VitaMamba: school feeding

3) Conclusions: Integrated Nutrition Programming
   a.) Water & microbiome
   b.) Anemia & child development
WHO Framework (Stewart et al. *MCN* 2013)
LNS & RUSF RESEARCH IN HAITI
Haiti: context

• History
  – Occupation, dependencies → weakened healthcare system
  – Major earthquake Jan 2010
  – Cholera & widespread diarrhea

• Rapid urbanization and poverty
  – >50% population live urban areas; 3.9 % per year
  – 80% in poverty (less than $2); 54% in abject poverty (<$1)
  – 10% land with permanent crops; deforestation; dependency on food imports

• Nutrition (DHS 2012)
  – 20.9% stunted, 11.4% underweight, 5.1% wasted
  – 65% of infants 6-59 mo were anemic; and 16.9% of children 6-59 mo live in HH with iodized salt
  – 23% 4 food groups/d; 7% eggs; 18% meat or fish

• Infection & WASH
  – 21% acute diarrhea; leading cause of child death.
  – 80% without access to sanitation
Cap Haitien
Fortified peanut butter paste

• Prevention, not treatment!
  – Intervene early to prevent stunting
  – Micronutrient nutrition in school age children

• Poverty intervention
  – high quality food + education
  – Local peanut farmers & economic development
COMPLEMENTARY FOOD SECURITY: NUTRIBUTTER TRIAL
Partners & Funders

Funders:
- Bill & Melinda Gates Foundation to FHI 360, through the Alive & Thrive Small Grants Program managed by UC Davis;
- World Bank;
- World Food Program;
- Inter-American Development Bank;
- World Food Program;
Objectives

To test the efficacy of a small-quantity lipid-based supplement (LNS), Nutributter® (NB), delivered within an integrated package of services (IP) on promoting linear growth, over time

• improve complementary feeding practices in poor urban context

• examine effects of NB on infant and young child feeding (IYCF) practices
Study Design – mixed methods

• **RCT & impact evaluation**
  - Control, 3-mo NB, 6-mo NB
  - Followed monthly for anthropometry, morbidity, and development outcomes
  - Sustained growth effect → 6 mo post-intervention

• **Qualitative research & process evaluation**
  - In-depth interviews, matrix scoring, focus groups, observations, etc.
  - Logic model framework

• **Geospatial analyses**
  - Handheld Global Positioning System (GPS) units to map (n=150) of households, water sources, sanitation, markets, health service providers, churches
Trial profile

**RCT**
*Recruited and screened (n=709)
* Enrolled and randomized (n=589)

- **Group 1**
  - Control group (n=191)

- **Group 2**
  - Nutributter 3 mo (n=196)

- **Group 3**
  - Nutributter 6 mo (n=202)

**Monthly follow-up visits: → 6 months**

**Intervention Period (6 mo)**

- 48 losses to follow-up
  - Control (n=144)

- 70 losses to follow-up
  - NB 3 mo (n=126)

- 52 losses to follow-up
  - NB 6 mo (n=150)

**POST-Intervention (6 mo)**

**Qualitative research & process evaluation**

**GIS analyses**
Qualitative Research
Intervention: Nutributter®

Ingredients: peanut paste, sugar, vegetable fat, dry skimmed milk powder, maltodextrines, whey, vitamin and mineral pre-mix, emulsifier
Interventions
MOH Integrated Package

• Integrated Management of Childhood Illness (IMCI)
  – Health education: community health agents provide information at clinic & rally posts
  – Vaccinations
  – Vitamin A supplementation
  – Growth monitoring & promotion
  – Reproductive health
RESULTS
# Growth effects – longitudinal regression

<table>
<thead>
<tr>
<th></th>
<th>3-mo NB vs. control</th>
<th>6-mo NB vs. control</th>
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<tr>
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<td>Unadj β (SE)</td>
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<td><strong>At 6 mo</strong></td>
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<tr>
<td>LAZ</td>
<td>-0.10 (0.05)</td>
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<td>WAZ</td>
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<td><strong>At 12 mo</strong></td>
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<td>LAZ</td>
<td>-0.09 (0.05)</td>
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<tr>
<td>WAZ</td>
<td>0.03 (0.05)</td>
<td>0.54</td>
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</tbody>
</table>
Public health: entire distribution shifted

Kernel density estimate

- Group 1: Control
- Group 2: NB for 3 mo
- Group 3: NB for 6 mo

kernel = epanechnikov, bandwidth = 1.4094
NB effects on IYCF

• Increased dietary diversity 0.23 ±0.07 SE (P<0.001)

• ↓ BF frequency 1.17 ±0.25 SE (P<0.001)

• ↑ water (84%) & sugar drinks (51%)

• Vitamin A supplementation
  – VAS in last 6 mo (99.3%)
  – 3-4 doses
  – 80% in NB groups > upper level
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Implications

• Small-quantity LNS
  – NB for 6+ mo from 6-11 mo to promote linear growth
  – Offer NB with IMCI, but re-visit VAS protocols

• Deliver targeted IYCF messages
  – Breastfeeding: reduce poverty stigma, continued breastfeeding
  – Complementary feeding: re-enforce the mixing with other foods, safe drinking water consumption

• Research: next steps
  – Transdisciplinary approaches – public health, anthropology, engineering, and genomic sciences
Acknowledgements

Washington University
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... the next 3,000 days

- **Brain development** – prefrontal cortex for higher cognitive functions; synaptogenesis and pruning; and neurogenesis in hippocampus (Grantham-McGregor et al. 2007)

- **Micronutrient deficiencies** - 20-30% of school-aged children have deficiencies in iron, iodine, zinc, and vitamin A (Best et al. 2011)
  - Haiti: 73% were anemic; 14% were stunted; 9.1% thin; and low % fat mass boys (8%) and girls (12.5%)

- **School feeding programs** - largest investments in public food programs globally (Lentz & Barrett 2013)
  - Potential for local agriculture development & nutrition impacts (Iannotti et al. 2013)
Mamba School Feeding Project

- McGovern-Dole International Food for Education and Child Nutrition
  - Micronutrient-fortified food aid products pilot

- Partners: Washington University, Edesia, National Soybean Research Laboratory, Ministry of Education/Haiti
Design & Methods

• Cluster-randomized controlled trial (quasi-experimental design)
  – Formative research/school profiles used to collect SES and nutrition to help match schools

• Sample & comparison groups (6 schools):
  – 1,200 school aged children 3-13 years
  – 1) control; 2) Tablet Sereyal (unfortified biscuit); 3) Mamba

• Impact & Process Evaluation
  – Impact outcomes – anemia, BIA, anthropometry, school attendance
  – Process outcomes – food acceptability, functionality, feasibility
High anemia prevalence, with limited RUSF impacts in urban context.
Gambia (5-13 yrs): girls (17-18%), boys (11-14%)
U.S. (5-18 yr): girls (15-24%), boys (14-18%)
Germany (3-18 yr): girls (18-20%), boys (15-20%)
Importance of body fat

• Brain development and metabolism (Murray et al. 2012)

• Thinnness in school children associated with ↑infectious disease, anemia, impaired cognitive/motor development (Heath & Taylor 2012)

• White adipose tissue – immunity, reproduction, and glucose/lipid metabolism; Brown adipose – regulates body temperature (Fruhbeck et al. 2013)
Mamba increases BMIz, fat mass, & %fat mass

| Table 5: Longitudinal regression models of intervention effects in Haitian school children |
|---------------------------------|---------------------------------|---------------------------------|
|                                | BMI z score¹                   | Fat mass,² kg                   | Fat mass,² %                     |
|                                | Group effect (n = 2329)        | Mamba effect (n = 1479)         | Group effect (n = 2460)          | Mamba effect (n = 1565) |
|                                | Coefficient ± SEE              | P                               | Coefficient ± SEE                | P                     |
| Group effect (Mamba = 3;       | 0.12 ± 0.03                    | <0.001                          | 0.21 ± 0.06                      | 0.001                 |
| Tablet Yo = 2; control = 1)²   |                                |                                 | 0.64 ± 0.13                      | <0.001                |
| Mamba effect (Mamba = 2;       |                                |                                 | 1.28 ± 0.27                      | <0.001                |
| control = 1)³                  |                                |                                 | 0.25 ± 0.06                      | 0.002                 |
|                                | Coefficient ± SEE              | P                               | 0.45 ± 0.14                      | 0.23                  |
|                                | 0.25 ± 0.06                    | <0.001                          | 0.24                             | <0.001                |
|                                | 1.28 ± 0.27                    | <0.001                          | 0.23                             | <0.001                |
|                                | 177.17                         | <0.001                          | 403.82                           | <0.001                |
|                                | 0.07                           | 0.08                            | 0.15                             | 0.14                  |
|                                | 130.00                         | 0.14                            | 229.66                           | 0.23                  |
|                                | 403.82                         | 0.15                            | 229.66                           | 0.23                  |
|                                | 0.24                           | 0.14                            | 732.41                           | <0.001                |
|                                | 319.00                         | 0.24                            | 431.31                           | <0.001                |
|                                | 732.41                         | 0.23                            |                                   |                      |
|                                | 431.31                         |                                 |                                   |                      |

¹ Generalized least squares regression with random effects adjusted for age of the child, maternal BMI, monthly income, and school cluster.

² Generalized least squares regression with random effects adjusted for age of the child, sex of the child, maternal BMI, monthly income, and school cluster.

³ A separate model was generated to examine the Mamba effect compared to control only, excluding the Tablet Yo group.

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Conclusions

INTEGRATED NUTRITION PROGRAMMING
Evaluation of Environmental Contaminants Affecting Water Quality in Haiti

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Anemia

• **Blood disorder**
  – Reduced concentration of hemoglobin in the blood
  – Consequences: weakness, fatigue; compromised cognitive and physical development in young children, poor birth outcomes in pregnant women, and in severe cases, increased risk of mortality in certain populations (Hoffbrand et al 2006)

• **1.62 billion people (95% CI: 1.50-1.74 billion)**
  – 64.8 million disability adjusted life years (DALYs).

**ANEMIA CAUSES**
• *nutritional deficiencies* (iron, vitamin A, vitamin B\(_{12}\), folate, riboflavin, and copper);
• *infection* (malaria, helminths, tuberculosis, HIV);
• *chronic disease* (cancers);
• *blood loss* (hemorrhage during delivery, injury);
• *hemoglobinopathies* (thalassemia, sickle cell anemia)
Pathways: from nutrition to child development

- **Nutrition:**
  - Stunting
  - Micronutrient deficiencies

- **Physical activity & growth**

- **Illness**

- **Brain development & function**

- **Caregiver interactions**

- **Environment interactions**

- **Sensori-motor**

- **Social-emotional**

- **Cognitive-language**
Conclusions

- Limiting nutrient deficiencies
  - LNS, RUSF (VitaMamba) early and do no harm ethic
  - Improve diet quality

- Prevention strategies
  - 1,000 days (IYCF, maternal nutrition)
  - 3,000 days (development, body comp)

- Integrated programming depending on context
  - WASH
  - Poverty alleviation
  - Agriculture
  - Education