Building Human Capital: Nutrition is Fundamental
Salon D: Des Moines Marriott Downtown Hotel
October 14, 2015

The economic impact of malnutrition in the developing world results in the loss or impairment of human capital. Sub-optimal nutrition can severely compromise development goals, and its impact is often underappreciated in both the development community and among the general public. The BIFAD seeks; therefore, to highlight this important issue and begin a dialogue with the nutrition community and other interested parties.

Agenda:

9:00 AM Welcome and Introduction. Dr. Brady Deaton, Chairman, BIFAD
9:05 AM USAID’s nutrition strategy under Feed the Future. Dr. Rob Bertram, Chief Scientist Bureau Food Security
9:15 AM Emerging Trends in the Global Pattern of Malnutrition: Under-Nutrition, Obesity, and Micronutrient Deficiency. Dr. William Masters, Tufts University
9:30 AM Cognitive and physical development of children and/or adults. Dr. Jessica Fanzo, Johns Hopkins Univ.
9:45 AM Economic and social impacts of malnutrition. Dr. John Hoddinott, Cornell University
10:00 AM Lessons from successful nutritional interventions. Dr. Grace Marquis, McGill University, Canada and Dr. Ana Lydia Sawaya, Federal University of São Paulo, Brazil
10:30 AM Robust discussion with panel and audience
11:00 AM Concluding remarks, Dr. Brady Deaton, Chairman, BIFAD

Links to Selected Papers Authored by Presenters and USAID Nutrition Policy

- USAID Multi-Sectoral Nutrition Strategy
  - https://www.usaid.gov/nutrition-strategy
  - http://jn.nutrition.org/content/133/11/3879S.long
- Agricultural policy for improved nutrition in Africa and Asia: Evidence to guide the US Government’s investments in food security – Food Security
- The role of food and nutrition system approaches in tackling hidden hunger – Int. J. Environ. Res. Public Health
- Height and weight gains in a nutrition rehabilitation day-care service – Public Health Nutr.
Biographies for World Food Prize Panelists

Dr. Robert Bertram

Rob Bertram is the Chief Scientist in USAID’s Bureau for Food Security, where he serves as a key adviser on a range of technical and program issues to advance global food security and nutrition. He previously served as Director of the Office of Agricultural Research and Policy in the Bureau for Food Security, which leads implementation of the Feed the Future research strategy and related efforts to scale innovations in global food security efforts, working with a range of partners. Prior to that, he guided USAID investments in agriculture and natural resources research for many years. Before coming to USAID, he served with USDA's international programs as well as overseas with the Consultative Group on International Agricultural Research (CGIAR) system. Dr. Bertram’s academic background in plant breeding and genetics includes degrees from UC Davis, the University of Minnesota and the University of Maryland. He also studied international affairs at Georgetown University and was a visiting scientist at Washington University in St. Louis.

Dr. William Masters

Will Masters is a Professor at Tufts University, in the Friedman School of Nutrition with a secondary appointment in the Department of Economics. His research focuses on the economics of agriculture and nutrition in rural Africa. Additionally, he serves as co-editor of Agricultural Economics, the journal of the International Association of Agricultural Economists. From 2011 to 2014 he served as chair of the Friedman School's Department of Food and Nutrition Policy, and before coming to Tufts was a faculty member in Agricultural Economics at Purdue University (1991-2010), and also at the University of Zimbabwe (1989-90), Harvard’s Kennedy School of Government (2000) and Columbia University (2003-04). From 2006 through 2011 he edited Agricultural Economics, the journal of the International Association of Agricultural Economists. He attended Deep Springs College, then graduated with a BA in Economics and Political Science from Yale University and then received a Ph.D. from the Food Research Institute of Stanford University.
**Dr. Jessica Fanzo**

Jessica Fanzo is a Bloomberg Distinguished Associate Professor at the School of Advanced International Studies and the Berman Institute of Bioethics at Johns Hopkins University. Jessica’s area of expertise focuses on the multi-sectoral and system approaches to ensure better nutrition and diets. Prior to coming to Johns Hopkins, Jessica was an Assistant Professor of Nutrition in the Institute of Human Nutrition and Department of Pediatrics at Columbia University in New York. She also served as the Senior Advisor of Nutrition Policy at the Center on Globalization and Sustainable Development. She has on-going nutrition development projects and collaborations with World Health Organization, UNICEF, UN World Food Programme, Bioversity International, World Fish and the World Bank. Jessica has a PhD in Nutrition from the University of Arizona and completed a Stephen I. Morse postdoctoral fellowship in Immunology at Columbia University.

**Dr. John Hoddinott**

John Hoddinott is the H.E. Babcock Professor of Food and Nutrition Economics and Policy at Cornell University. Previously, he was a Deputy Division Director at the International Food Policy Research Institute, Washington DC. He has been heavily involved in primary data collection through living in a mud hut in western Kenya and a small town near Timbuktu Mali as well as developing longitudinal and cross-sectional household surveys in Bangladesh, Cote d’Ivoire, Ethiopia, Guatemala, Kenya, Mali, Namibia, Niger and Zimbabwe. He has more than 100 refereed publications including studies of the long-term consequences of early childhood undernutrition and the evaluation of interventions designed to reduce poverty, hunger and undernutrition in developing countries. Born in Canada, he has a BA in Economics from the University of Toronto and a doctorate in economics from the University of Oxford.
Dr. Grace Marquis

Grace S. Marquis is an Associate Professor and Canadian Research Chair in Social and Environmental Aspects of Nutrition at McGill University in Canada. Her research career began more than 30 years ago at the Nutrition Research Institute in Lima, Peru. In 1999, her research group began working in Ghana, West Africa. The long-term collaborations in both countries continue today. Her community-based research has examined determinants of diet and nutritional status of infants and young children living in poverty and the means by which individuals, communities, and societies can intervene to promote optimal feeding and caregiving for young children. Her research group develops cross-sector, integrated strategies that support child health and growth, with a special focus on those living in rural communities. She has a BA from Indiana University, MSc from Michigan State University, and a doctorate in international nutrition from Cornell University. Dr. Marquis received a Doctorate of Laws, honoris causa, for her contribution to tertiary education from the University of Ghana in 2013.

Dr. Ana Lydia Sawaya

Ana Lydia Sawaya is an associate professor at the Federal University of São Paulo in Brazil. Her research is on the effect of protein-energy malnutrition in children, adolescents and adults, and its association with obesity and risk of chronic diseases. More recently, the focus is on the effect of nutritional recovery of malnourished children. Sawaya studies populations that live in slums and tenements in various parts of Brazil. In 1994, she started the University Extension Project: Center for Recovery and Nutritional Education (CREN), coordinating it until 2006. She is currently the Scientific Director with the CREN which has been recognized as a national reference for combating malnutrition and has received national and international awards for its performance. She graduated in Biological Sciences from the University of São Paulo, obtained two master’s degrees - in Physiology from the University of São Paulo and in Nutrition from the University of Cambridge, and a Ph.D. in Nutrition from the University of Cambridge.
Building Human Capital: Nutrition is Fundamental

Board for International Food and Agricultural Development (BIFAD)
2015 Borlaug Dialogue International Symposium
October 14, 2015

Multiple Burdens in the Developing World

• Undernutrition leads to physical and cognitive stunting, as well as greater susceptibility to disease
• Micronutrient deficiency leads to a range of illnesses and functional impairments
• Overweight and obesity result in diabetes and cardiovascular disease
Today’s Panel

- Rob Bertram, USAID
- Will Masters, Tufts University
- Jessica Fanzo, Johns Hopkins University
- John Hoddinott, Cornell University
- Grace Marquis, McGill University
- Ana Lydia Sawaya, Federal University of Sao Paolo, Brazil
The global pattern of malnutrition: From undernutrition to obesity and diet-related disease

Will Masters
Friedman School of Nutrition Science & Policy, Tufts University
www.nutrition.tufts.edu | http://sites.tufts.edu/willmasters

Building Human Capital: Nutrition is Fundamental
BIFAD side event at the World Food Prize 2015 Borlaug Dialogue
October 14th, 2015

In fifty years, from more food to better food

Percent of energy from non-staple foods and total dietary energy by region, 1961-2011 (FAO Food Balance Sheet estimates)

The global pattern of malnutrition: stunting | wasting | obesity | disease

Fifteen years into the 21st c., we have:

- **Progress on stunting and wasting**
  …but still far to go
- **Sharp rise in obesity**
  …and more to come
- **Rapid shift in diet-related diseases**
  …even in developing countries

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How has the food system changed?

- **Are countries just richer, or different in other ways?**
  - Richer = more of everything, both public and private
  - Different = new things, both technologies and institutions

- **Strategy**
  - test for shifts in the global average at each level of national income
  - this generalizes the Preston curve (Preston 1975, Bloom & Canning 2007), first applied to life expectancy

- **Data**
  - national income: purchasing power per capita
  - height and weight: stunting, wasting and obesity
  - disease burden: diabetes and diarrhea (% of DALYs lost)

- **Method**
  - all data are nationally representative; results are weighted by population
The main development goal:
child stunting

Pct. of children under 5, 1985-99 [n=250] and 2000-11 [n=337]

O = 1985-99
□ = 2000-11

Clear progress against child stunting, at each level of income

Note: Symbols are sized by population, with decades shown by green circles for 1986-99 (250 surveys in 193 countries) and blue squares for 2000-2011 (337 surveys in 117 countries). Lines show local means and confidence intervals for each period estimated by -lpoly-, weighted by population and with a bandwidth of 0.75.
Source: World Bank, WHO and UNICEF joint data; GDP and population are from PWT 8.1.
The global pattern of malnutrition

stunting | wasting | obesity | disease

Focusing on the poorest in recent years, we can zoom in to see FTF countries’ gains.

UNICEF/WHO/WB survey data on child stunting since 2000 in poor countries
Pct. of children under 5, 2000-05 [n=118] and 2006-11 [n=118]

Note: 2007-09=green circles, 2000-11=blue squares, with darker colors for FTF focus countries of which a few are labeled. Lines show each period’s local means and confidence intervals estimated by -lpoly-, weighted by population and with a bandwidth of 0.75.

Source: World Bank, WHO and UNICEF joint data; GDP and population are from PWT 8.1.

Less prevalent, but still serious:

child wasting
Child wasting rates have also fallen

The global pattern of malnutrition

stunting | wasting | obesity | disease

The most visible kind of change:

adult obesity
Adult obesity had a clear income gradient in 1990

The global pattern of malnutrition
stunting | wasting | obesity | disease

From 1990 to 2010, did the income gradient shift?

But China and India may be influential
Adult obesity has shifted up in richer countries

The global pattern of malnutrition
stunting | wasting | obesity | disease

The worst diet-related disease:
diabetes
Diabetes burdens in 1990

The global burden of diabetes (share of DALYs lost)
Modeled estimates for 1990 in 162 countries

A clear income gradient
...but also more variance at higher incomes

Note: Symbols are sized by population, with year shown as 1990=green circles.

Source: Global Burden of Disease Study, Results by Cause; GDP and population are from PWT 8.1.

Diabetes burdens in 1990, with local means

The global burden of diabetes (share of DALYs lost)
Modeled estimates for 1990 in 162 countries

Note the wider confidence interval at higher incomes

Note India and China are near their local means

Note: Symbols are sized by population, with year shown as 1990=green circles.

Lines show each year's local means and confidence intervals estimated by \(-lpolyci\), weighted by population and with a bandwidth of 0.75.

Source: Global Burden of Disease Study, Results by Cause; GDP and population are from PWT 8.1.
Changes in diabetes from 1990 to 2005

The global burden of diabetes (share of DALYs lost)
Modeled estimates for 1990 and 2005 in 162 countries

From 1990 to 2005, relative burden rose in lower and middle income countries

China and India shifted up and along the same curves as other countries

Diabetes burdens have risen in poor countries

The global burden of diabetes (share of DALYs lost)
Modeled estimates for 1990, 2005 and 2010 in 162 countries

Diabetes burdens have risen in poor countries

From 1990 to 2005; no significant further rise to 2010

Note: Symbols are sized by population, with year shown as 1990=green circles, 2005=red triangles, and 2010=blue squares. Lines show each year’s local means and confidence intervals estimated by -lpoly-, weighted by population and with a bandwidth of 0.75.

Source: Global Burden of Disease Study, Results by Cause; GDP and population are from PWT 8.1.
Now contrast with the signature illness of undernourishment: diarrheal disease

Diarrhea burdens have fallen but are still large

The global burden of diarrheal disease (share of DALYs lost) Modeled estimates for 1990, 2005 and 2010 in 162 countries

- India remains an outlier
- What happened at each income level other than India & China?

China

Note: Symbols are sized by population, with year shown as 1990=green circles, 2005=red triangles, and 2010=blue squares. Lines show each year's local means and confidence intervals estimated by -lpoly-, weighted by population and with a bandwidth of 0.75.

Source: Global Burden of Disease Study, Results by Cause; GDP and population are from PWT 8.1.
Diarrhea burdens have fallen but are still large

In conclusion:
Fifteen years into the 21st c., we have...

- **Progress on stunting and wasting**
  ...large gains from higher income,
  and also big improvement in poor countries

- **Sharp rise in obesity**
  …so far, almost entirely due to higher income
  and also worsening in the richest countries

- **Rapid shift in diet-related diseases**
  …worsening of diabetes at low and middle incomes
  while diarrhea is improving in poor countries
Looking forward:
In the coming decades, we can…

• **Complete eradication of stunting and wasting**
  …and reap large gains
  in later health & cognition

• **Bend the curve of obesity**
  …and reverse its rise
  at higher incomes

• **Treat and prevent diet-related diseases**
  …such as diabetes and diarrhea

Acknowledgements

Global Dietary Database
(BMGF)

Feed the Future Innovation Lab for Nutrition
(USAID)

Feed the Future Policy Impact Study Consortium
(USDA)
thank you!
The Importance of Diets and Micronutrients for Nutrition and Human Health

Jessica Fanzo, PhD
Johns Hopkins University

Why is Diet Important?

Dietary risks accounting for 11.3 million deaths and 241.4 million DALYs

(A) Global DALYs attributed to risk factors in 2000 for both sexes combined

(B) Global DALYs attributed to risk factors in 2013 for both sexes combined

GBD 2013 Risk Factors Collaborators; Lancet 2015
Why is Dietary Diversity and Quality Important?

- Dietary diversity is one important dimension of dietary quality.
- Dietary diversity relates to micronutrient intakes/adequacy (Arimond et al 2010; Kant 1996).
- Income can determine dietary quality (Black et al 2008).
- Dietary diversity is associated with undernutrition (Arimond and Ruel 2004).

### How the Global Hunger Index Correlates with Measures of Hidden Hunger

<table>
<thead>
<tr>
<th>Low dietary diversity</th>
<th>Anemia</th>
<th>Vitamin A deficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>N = 64</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N = 62</td>
<td></td>
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<td>N = 59</td>
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<td>N = 27</td>
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<tr>
<td>N = 55</td>
<td></td>
<td></td>
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<tr>
<td>N = 49</td>
<td></td>
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</tbody>
</table>

- Global Hunger Index
- Under-five mortality rate
- Prevalence of underweight in children
- Proportion of undernourished children
- Not significant ($p>0.05$)

Notes: Spearman rank correlation coefficients can range from 0 (no association) to 1 (perfect association). All correlations with the GHI are statistically significant at $p<0.05$. For the GHI components, solid color indicates significance at $p<0.05$. Not all countries have data for all GHI components or year of the survey and the GHI reference period. N indicates the number of countries for which the correlation coefficients could be computed.

Definitions and data sources. Low dietary diversity: Proportion of children 6-23 months who consume fewer than four out of seven food groups (green, millet and tubers, legumes and nuts, dairy products, milk and dairy, eggs, vitamin-A rich fruits and vegetables, other fruits and vegetables). Under-five mortality rate: 928 children under five per 1000. Prevalence of underweight in children: Underweight at reference level or less than 6.0 kg in girls or less than 5.0 kg in boys. Proportion of undernourished children: Proportion of children whose hemoglobin level is less than 11.0 g/dl in girls, or less than 12.0 g/dl in boys. Vitamin A deficiency: Proportion of preschool-age children with night blindness, proportion of pregnant women with night blindness, and proportion of preschool-age children whose serum retinol level is less than 0.70 micromoles per liter (WHO 2009).
Hidden Hunger is Associated with Human Development

Global map presenting hidden hunger index based on the prevalence estimates in 149 countries and prevalence of low urinary iodine concentration in 90 countries with 2007 Human Development Index.

The association between hidden hunger index based on the prevalence estimates (HHI-PD) and 2007 Human Development Index (HDI).


Some Causes for Concern

- Metrics
- Quality
- Cost
- Sustainability
Quality of Diets

Global mean intake of fruit for adults > 20 years of age in 2010

Cost of Diets

Keating and Wiggins, ODI 2014; Chastre et al 2007 STC
Sustainability of Diets

Are dietary guidelines thinking about sustainability?

Is our food supply able to provide the necessary diversity?

Wiggins and Keats 2013 ODI Dietary Shifts Report

Khoury et al 2014 PNAS

Potential Solutions to Improve Micronutrient Status and Dietary Diversity

• Strengthened value chains that focus on nutritious foods at the bottom of the pyramid
• Home and community gardens (where appropriate)
• Specialized food products – micronutrient powders, lipid based supplements
• Biofortified staple crops
• Specialized extension services
• Consumer knowledge on purchases and cooking
Thank you

Contact Info:
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School of Advanced International Studies (SAIS)
Berman Institute of Bioethics
Johns Hopkins University
Twitter: @jessfanzo
ECONOMIC AND SOCIAL IMPACTS OF MALNUTRITION

John Hoddinott, Cornell University
October 14, 2015

WORLD FOOD PRIZE 2015 SIDE EVENT
BUILDING HUMAN CAPITAL: NUTRITION IS FUNDAMENTAL HOSTED BY BIFAD

Motor cortex dentrites in undernourished and well nourished children

Well nourished children

Undernourished children

Figure 3: Pyramidal cell dendrites from (a) well-nourished and (b) malnourished infants. On the left side, normal cells from (a) normal children.

Cordero et al, 1993
Neurological consequences of undernutrition

- When thinking about the functional consequences of undernutrition, the focus is typically on height. This misses the more important, and pernicious neurological effects.

- In severely malnourished children, dentrites in the motor cortex and in the occipital lobe (responsible for the processing of visual information) are shorter, having fewer spines and greater numbers of abnormalities; consequently, chronic malnutrition leads to delays in the evolution of locomotor skills.

- Early life malnutrition damages the hippocampus by reducing dentrite density. This adversely affects spatial navigation and memory formation.

- Chronic undernutrition results in reduced myelination of axon fibers thus reducing the speed at which signals are transmitted.

Evidence on the economic and social consequences of chronic undernutrition: The Oriente (INCAP) study: 1969-77 Nutrition Intervention

- In the 1960s, protein deficiency was seen as the most important nutritional problem facing the poor in developing countries. The Institute of Nutrition of Central America and Panama (INCAP), in Guatemala, was the locus of a series of studies on this subject, leading to a nutritional supplementation trial begun in 1969.

- Matched pair sets of Guatemalan villages randomized into:
  - Atole – high protein, high calorie, micronutrients
  - Fresco – no protein, low calorie, micronutrients

- Centrally located feeding center open at convenient hours, on-demand service

- Free preventative healthcare including immunization and antiparasites campaigns

- Enrolled all 0-7 year olds in 1969, all new births included until after supplementation abruptly ended in 1977
The 2002-04 Human Capital Study

• Between 2002–04, we attempted to trace the 2392 participants in the 1969–77 study. Sample members ranged from 25 to 42 years of age. We successfully found and interviewed 1471 individuals (62% of the original sample; 79% of those targeted for interview)

• Over the two year period of the study, respondents completed four interviews (approximately eight hours in total) covering:
  ◦ Schooling, marital and fertility histories
  ◦ Took tests of reading and non-verbal cognitive ability
  ◦ Provided information on income and consumption
  ◦ Underwent physical examinations, took fitness tests and provided blood samples to measure blood glucose and cholesterol levels

Selected impact of nutritional status on outcomes across the lifecourse (+1 SD increase in HAZ at age 24m): Schooling

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Unit</th>
<th>β</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age Start School</td>
<td>Years</td>
<td>-0.21</td>
<td>0.068</td>
</tr>
<tr>
<td>Age left school</td>
<td>Years</td>
<td>0.54</td>
<td>0.025</td>
</tr>
<tr>
<td>Highest grade attained</td>
<td>Grades</td>
<td>0.78</td>
<td>0.003</td>
</tr>
<tr>
<td>SIA z score</td>
<td>SD</td>
<td>0.28</td>
<td>0.003</td>
</tr>
<tr>
<td>Raven’s z score</td>
<td>SD</td>
<td>0.25</td>
<td>0.002</td>
</tr>
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</table>

Hoddinott et al (2013)
Selected impact of nutritional status on outcomes across the lifecourse (+1 SD increase in HAZ at age 24m): Labor market

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Unit</th>
<th>β</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Men</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wages</td>
<td>%</td>
<td>14</td>
<td>0.080</td>
</tr>
<tr>
<td>Likelihood of operating own business</td>
<td>Percentage points</td>
<td>4</td>
<td>0.279</td>
</tr>
<tr>
<td>Women</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wages</td>
<td>%</td>
<td>5</td>
<td>0.745</td>
</tr>
<tr>
<td>Likelihood of operating own business</td>
<td>Percentage points</td>
<td>11</td>
<td>0.010</td>
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</tbody>
</table>

Hoddinott et al (2013)

Selected impact of nutritional status on outcomes across the lifecourse (+1 SD increase in HAZ at age 24m): Marriage

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Unit</th>
<th>B</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age at first marriage</td>
<td>Years</td>
<td>0.40</td>
<td>0.185</td>
</tr>
<tr>
<td>Partners’ age</td>
<td>Years</td>
<td>1.39</td>
<td>0.006</td>
</tr>
<tr>
<td>Partners’ highest grade attained</td>
<td>Grades</td>
<td>1.02</td>
<td>0.001</td>
</tr>
<tr>
<td>Partners’ height</td>
<td>cm</td>
<td>1.01</td>
<td>0.046</td>
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</tbody>
</table>

Hoddinott et al (2013)
Selected impact of nutritional status on outcomes across the lifecourse (+1 SD increase in HAZ at age 24m): Fertility

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Unit</th>
<th>β</th>
<th>P value</th>
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</thead>
<tbody>
<tr>
<td>Age at first birth</td>
<td>Years</td>
<td>0.77</td>
<td>0.043</td>
</tr>
<tr>
<td>Number of pregnancies</td>
<td>Number</td>
<td>-0.63</td>
<td>0.003</td>
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<tr>
<td>Number of living children</td>
<td>Number</td>
<td>-0.43</td>
<td>0.032</td>
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Hoddinott et al (2013)

Selected impact of nutritional status on outcomes across the lifecourse (+1 SD increase in HAZ at age 24m): Consumption and poverty

<table>
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<tr>
<th>Outcome</th>
<th>Unit</th>
<th>β</th>
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</tr>
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<tbody>
<tr>
<td>Per capita household expenditure</td>
<td>%</td>
<td>21</td>
<td>0.001</td>
</tr>
<tr>
<td>Poverty</td>
<td>Percentage points</td>
<td>-10</td>
<td>0.014</td>
</tr>
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Hoddinott et al (2013)
Summary

Specific

• Study team back in Guatemala for follow up survey:
  • Update findings on wages, human capital to see if these effects persist or fade out
  • Additional focus on health and agency

General

• Conventional wisdom has been to see nutrition (broadly defined) as a consequence or outcome of (general) development processes
• These findings suggest that, at the very least, much more weight should be given to seeing this relationship from the other direction; from better nutrition to (economic) development
Lessons from successful nutritional interventions

The ENAM Project

Grace S. Marquis
School of Dietetics and Human Nutrition
McGill University

BACKGROUND

1980-2000
Animal source foods (ASF) predicted child physical growth, cognitive function, school performance, physical activity

2002
Global Livestock CRSP Program (US-AID) sought proposals that addressed the question:

What are the constraints to the availability, accessibility, preparation, and allocation of ASF for children in developing countries?
ENAM

Enhancing child Nutrition through Animal source food Management

Project collaborators:
University of Ghana: Esi Colecraft, Anna Larney, Owuraku Sakyi-Dawson, Ben Ahunu
Iowa State University: Lorna Butler, Helen Jensen, Manju Reddy, Elisabeth Huff-Lonergan

Enam=animal flesh protein (Twi)

Project stakeholders

Ministry of Food & Agriculture (MOFA)
Women in Agricultural Development (MOFA)
Ghana Health Services
Commodity groups
Non-governmental organizations
   Heifer-Ghana
   Freedom from Hunger-Ghana
Universities
Communities

Agro-business
Economics
Nutrition
Formative research led to a model of constraints on ASF for pre-school children

Agro-business skills
- Animal husbandry, food processing & storage
- Marketing linkages

Nutrition knowledge
- ASF
  - Availability
  - Accessibility
  - Utilization

Child nutrition knowledge
- Cultural beliefs about foods

Household food allocation

Women’s access to income

Economics

16-months intervention in...

3 ecological zones
- 2 intervention communities/zone
  - Total n=179 households enrolled
- 2 comparison communities/zone
  - Total n=287 households enrolled

Guinea savannah

Forest transitional

Coastal savannah
Component 1: Training in agro-business

Agro-business skills

ASF
Availability
Accessibility
Utilization

1. Group entrepreneurial education

Part of weekly group meeting

Flip charts for group discussion
- Marketing and customer care
- Record keeping
- Financial literacy

Skits on lessons learned
Component 2: Training in nutrition

Nutrition knowledge & skills
- ASF
- Availability
- Accessibility
- Utilization

2-1. Group nutrition education

Flip charts for group discussion
- Growing well
- Child feeding styles
- Malnutrition signs
- Benefits of ASF
- Balanced plate
- Hygiene
2-2. Cooking competition

*Evaluation of meal prepared*

- Rationale focused on child
- Knowledgeable about nutritional value
- Includes ASF and iodized salt
- Practical
- Adequate portion size

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**Hygiene**

**Feeding style**

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Component 3: Access to economic services/microcredit

- ASF
- Availability
- Accessibility
- Utilization

**Economics**
3-1. Selection of income-generating activities (IGA)

Community → ENAM Team → Community
- Develop list of IGA
- Reviewed IGA suitability
- Cash flow analysis
- Consensus on IGA to support
- Develop support packages for selected IGA
- Promotion of selected IGA

Project-supported economic activities
- Fish smoking
- Fish selling (fish mongering)
- Poultry egg production
- Selling of foodstuffs (yams)
- Selling of cooked foods
- Processing & sale of foods (shea butter, rice parboiling)
3-2. Introduction of micro-credit

**Orientation training**

Eligible caregivers of pre-school children (3-5/group)

Loan requirements:
- Group concept
- $50 maximum initially
- Loan cycle (16 wk)
- Repayment weekly
- Savings (10%)
- Education

Future loans require:
- Meeting attendance
- Savings
- Group appraisal

**Group self-selection**

- Solidarity group
- Solidarity group
- Solidarity group

**Loan appraisal**

- Village Credit & Savings Association (CSA)
  - CSA leadership
  - CSA by-laws

3-3. Additional IGA-specific training

**Poultry raising**

- Coup construction & maintenance
- Poultry health
- Feed management
- Marketing poultry products

**Fish smoking**

- Construction of improved smoking ovens
- Demonstration oven
- Fish handling
- Smoked fish preservation
**Evaluation approach**

**Data collection**

- **Baseline**
  - $I=179$; $C=287$
- **FUP1, 4 mo**
  - $I=176$; $C=278$
- **FUP2, 8 mo**
  - $I=153$; $C=268$
- **FUP3, 12 mo**
  - $I=127$; $C=251$
- **FUP4, 16 mo**
  - $I=97$; $C=239$

**Longitudinal data collected**

- Microcredit performance
- Meeting attendance
- Repayments
- Savings
- Cash flow for IGA (sub-sample)

**Household**

- Socio-demographic
- Food security
- ASF expenditures

**Caregiver**

- Child nutrition/health knowledge

**Child**

- Dietary intakes
- FFQ
- Weighed food (subsample)
- Anthropometry

**Other data collected**

- Case studies (post intervention only)

---

**Question 1. Did the intervention occur as planned?**

![Attendance chart](chart.png)

- **Central**
- **Brong-Ahafo**
- **Upper East**

- **Upper East Region**
- **Brong-Ahafo Region**
- **Central Region**
**Question 2. Did the identified ASF constraints change?**

**Women’s perception of improved businesses**

<table>
<thead>
<tr>
<th></th>
<th>Intervention (n=80)</th>
<th>Comparison (n=80)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Changes in enterprise</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Expanded, % (n)</td>
<td>82.5 (66)</td>
<td>46.3 (37)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Diversified, % (n)</td>
<td>23.8 (19)</td>
<td>6.3 (5)</td>
<td>&lt;0.01</td>
</tr>
</tbody>
</table>

“I know I am doing well and am more successful than other members. I believe in the project. I follow their lessons well and practice most of the things we are taught”.

Homiah et al. *AJFAND* 2012
Butler et al. *AJFAND* 2012
Loans and savings increased over time

Mean value of loan per cycle

Mean savings per cycle

1GH₵ = $0.9371

Women’s report of improved business performance

<table>
<thead>
<tr>
<th></th>
<th>Intervention (n=80)</th>
<th>Comparison (n=80)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Profit</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Increased, %</td>
<td>81.2</td>
<td>31.3</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Amount, GH₵</td>
<td>19.30 ± 2.21</td>
<td>12.21 ± 1.86</td>
<td>0.08</td>
</tr>
</tbody>
</table>

1 mean ± SE

Homiah et al. AJFAND 2012
**Why were some women more successful?**

"I know Akosua (fictitious name) is not doing well because, although she is a fishmonger, she has not been in the business for a long time as others have. Those who were in the business already used the loans they obtained to expand their businesses by buying more fishing nets, but she had to start from scratch. I therefore attribute her lesser success to little experience in her line of business."

Butler et al. AJFAND 2012

---

**Intervention was linked to ASF purchases**

<table>
<thead>
<tr>
<th></th>
<th>Intervention</th>
<th>Comparison</th>
<th>( p )</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASF purchased</td>
<td>11.03 ± 3.50</td>
<td>6.44 ± 0.78</td>
<td>0.067</td>
</tr>
<tr>
<td>ASF not purchased</td>
<td>5.87 ± 0.73</td>
<td>4.90 ± 0.66</td>
<td>0.648</td>
</tr>
<tr>
<td>Total ASF consumed</td>
<td>16.09 ± 1.59</td>
<td>10.49 ± 0.72</td>
<td>0.001</td>
</tr>
</tbody>
</table>

Mean ± SE

US$1=GH₵ 0.92

Total ASF consumed=purchased + non-purchased

Homiah et al. AJFAND 2012
### Intervention was associated with improved nutrition knowledge

<table>
<thead>
<tr>
<th></th>
<th>Intervention</th>
<th>Comparison</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caregivers’ endline knowledge score</td>
<td>37.2 ± 1.8&lt;sup&gt;1&lt;/sup&gt;</td>
<td>22.2 ± 0.7</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Change in score from baseline, % increase</td>
<td>80.4</td>
<td>60.6</td>
<td>&lt;0.01</td>
</tr>
</tbody>
</table>

<sup>1</sup>Mean ± SE

“... I did not know that meat or eggs were good for children and would make them grow well. In our culture, meat is usually not given to children, so anytime I prepared food with meat, I would give the meat to the adults. As kids, our parents used to eat all the meat themselves and tell us that children do not eat meat. Now I know meat and eggs will make a child grow well and strong.”

---

### Nutrition knowledge was associated with child ASF intake

![Graph showing the association between nutrition knowledge and child ASF intake.](image)

“Nutrition knowledge was associated with child ASF intake. The graph shows a significant difference in child ASF frequency and diversity between high and low knowledge groups, with p<0.05.”

---

Butler et al. AJFAND 2012

Christian et al. PAA conference. 2013

Christian et al. submitted
### Question 3. Did nutritional status improve?

#### Intervention linked to more diverse ASF in past week

- **Baseline**:
  - Meat
  - Fish
  - Poultry
  - Eggs

- **Endline**:
  - Meat
  - Fish
  - Poultry
  - Shellfish
  - Eggs
  - Milk

Significant group differences (p<0.05):
- Baseline: organ meat, poultry, eggs
- Endline: meats, organ meat, poultry, shellfish, eggs, milk

---

Marquis & Colecraft. Food Nutr Bull 2014
**Conclusions**

Providing loan opportunities and entrepreneurial education → improved small businesses & increased caregivers’ profits & savings

Providing nutrition education → improved caregivers’ nutrition knowledge

Integrated intervention → increased ASF in children’s diets & improved child growth (weight & height)
Intervention had not only benefits for the child. The frequent social interactions improved the lives of women who reported ...

* improved relationships with customers and others,
* enhanced self-confidence,
* perceived independence, and
* public speaking and teaching abilities.

The ENAM Project was funded through the Global Livestock-CRSP funded in part by US-AID Grant No. PCE-G-00-98-00036-00; Women in Development, US-AID; and the Jim Ellis Graduate Mentorship Program. In addition, substantial support was provided by Iowa State University, the University of Ghana, and McGill University.
LONG-TERM CONSEQUENCES OF MALNUTRITION AND THE EFFECT OF NUTRITIONAL RECOVERY

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Paula Andrea Martins
Vinicius Jose B. Martins
Telma M. Toledo Florêncio
Daniel Jay Hoffman
Maria do Carmo P. Franco
Janaina das Neves

Federal University of São Paulo
Department of Physiology
Section Physiology of Nutrition

- Short stature
- Obesity
- Hypertension
- Diabetes

Energy Intake during growth
Western diet and/or Physical inactivity

- Kidney/Vascular Changes
- Cortisol:Insulin
- Fat oxidation
- Muscle Gain
- Linear growth
- Waist:Hip ratio
- Fat gain

Short stature
Obesity
Hypertension
Diabetes
Day-hospital and outpatient treatment

Physician and dietitian working together
Son given up for adoption

MAP OF THE SOCIAL NETWORK

I = sister
V = neighbour
Gr = son-in-law
Sg = mother-in-law

Ø = drug addiction
Є = delinquency
TEACHER SUPERVISING MEALTIME
Laboratory for Food Handling
ANOVA: cluster \[F(1,62)=4.70; p<0.05\], birth weight \[F(1,62)=7.46; p<0.01\], interaction \[F(1,62)=0.08; p=ns\]
### BODY COMPOSITION OF CONTROL, OUTPATIENT AND DAY-HOSPITAL GROUPS OF GIRLS AND BOYS AT FOLLOW-UP

|                | Girls | | | | | |          |          |
|----------------|-------|---|---|---|---|---|---|---|---|---|---|---|---|---|
|                | Control (n = 5) | Outpatient (n = 7) | Day-hospital (n = 18) | P-value | Control (n = 15) | Outpatient (n = 12) | Day-hospital (n = 18) | P-value |
| Body fat, kg   | 6.9 ± 2.6   | 3.8 ± 0.9<sup>a</sup> | 4.0 ± 1.0<sup>a</sup> | 0.006    | 6.2 ± 2.2<sup>b</sup> | 3.9 ± 1.4<sup>a</sup> | 3.6 ± 0.7<sup>a</sup> | 0.001    |
| Body fat, %    | 46.4 ± 4.5<sup>b</sup> | 19.9 ± 3.4<sup>a</sup> | 19.9 ± 2.6<sup>a</sup> | 0.016    | 20.5 ± 5.0<sup>c</sup> | 17.7 ± 3.4<sup>a</sup> | 15.4 ± 2.4<sup>a</sup> | 0.007    |
| Lean mass/height, g/cm | 145 ± 13 | 130 ± 10 | 131 ± 14 | 0.112 | 173 ± 18<sup>c</sup> | 146 ± 29<sup>a</sup> | 151 ± 17<sup>a</sup> | 0.003 |
| Fat-free mass, kg | 18.7 ± 3.2 | 15.3 ± 1.8 | 15.1 ± 2.5 | 0.104 | 23.6 ± 4.4<sup>b</sup> | 18.4 ± 3.5<sup>a</sup> | 19.9 ± 3.2<sup>a</sup> | 0.012 |
| Fat-free mass index, kg/m² | 12.5 ± 0.3 | 11.9 ± 0.7 | 11.8 ± 1.1 | 0.269 | 13.9 ± 0.7<sup>b</sup> | 12.7 ± 1.3<sup>a</sup> | 12.8 ± 0.9<sup>a</sup> | 0.002 |

<sup>1</sup> Values are means ± SD. Means in a row without a common superscript differ, P < 0.05.

---

### INCREASED PROTEIN AND IRON CONSUMPTION AFTER NUTRITIONAL RECOVERY IN DAY-HOSPITAL (3-6 y after discharge)

|                | Group | | | | | |          |          |
|----------------|-------|---|---|---|---|---|---|---|---|---|---|---|---|---|
|                | Control (n = 28) | Outpatient (n = 28) | Day-hospital (n = 38) | P-value |
| Energy, 1 kJ/(kg·d) | 373.0 ± 43.0 (84) | 455.8 ± 42.3 (109) | 454.9 ± 37.2 (112) | 0.288 |
| Macronutrients<sup>2</sup> | | | | |
| Protein, g/(kg·d) | 1.7 ± 0.1 (13) | 1.9 ± 0.1<sup>a</sup> (15) | 2.1 ± 0.0<sup>b</sup> (15) | 0.015 |
| Fat, g/(kg·d) | 1.5 ± 0.1 (25) | 1.4 ± 0.1 (24) | 1.7 ± 0.0 (26) | 0.154 |
| Carbohydrate, g/(kg·d) | 8.0 ± 0.5 (64) | 8.3 ± 0.5 (61) | 8.8 ± 0.4 (59) | 0.406 |
| Micronutrients<sup>1</sup> | | | | |
| Calcium, mg/d | 367.3 ± 36.2 (36) | 350.7 ± 36.5 (35) | 417.9 ± 31.4 (39) | 0.347 |
| Iron, mg/d | 9.5 ± 0.5 (105) | 7.3 ± 0.5<sup>a</sup> (73) | 8.5 ± 0.4 (84) | 0.006 |
| Zinc, mg/d | 4.7 ± 0.4 (68) | 3.7 ± 0.5 (46) | 5.1 ± 0.4 (87) | 0.105 |
| Vitamin C, mg/d | 79.9 ± 12.7 (214) | 69.6 ± 12.5 (151) | 58.9 ± 11.0 (123) | 0.477 |
| Vitamin A, µg/d | 259.0 ± 31.2 (51) | 254.6 ± 30.7 (59) | 267.8 ± 27.0 (52) | 0.948 |

<sup>1</sup> Values are means ± SD and (%) of adequacy in relation to the DRI (38). Means in a row without a common superscript differ, P < 0.05.

<sup>2</sup> Values are means ± SD and (%) of energy content. Means were adjusted for gender, age, and pubertal stage by ANCOVA, P-value for the effect of group. Means in a row without a common superscript differ, P < 0.05.
NORMAL INSULIN, HOMEOSTASIS MODEL ASSESSMENT OF PANCREATIC β-CELL FUNCTION (HOMA-B), INSULIN SENSITIVITY (HOMA-S) AND GLUCOSE CONCENTRATION AFTER NUTRITIONAL RECOVERY

<table>
<thead>
<tr>
<th></th>
<th>Boys</th>
<th>Girls</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Control</td>
<td>Recovered</td>
</tr>
<tr>
<td></td>
<td>n</td>
<td>Mean</td>
</tr>
<tr>
<td>Insulin (pmol/l)*</td>
<td>15</td>
<td>3.62</td>
</tr>
<tr>
<td>Glucose (mg/dl)</td>
<td>15</td>
<td>788.0</td>
</tr>
<tr>
<td>HOMA-B (%)*</td>
<td>15</td>
<td>4.71</td>
</tr>
<tr>
<td>HOMA-S (%)*</td>
<td>15</td>
<td>4.85</td>
</tr>
</tbody>
</table>

NS, P < 0.05.
*Logarithmically transformed.
†From analysis of covariance with means adjusted for age and pubertal stage.

Whole body BMC (A), BMC/height (B) and BMD (C) of the Control, Outpatient, and Day-Hospital groups. The box represents the interquartile range (50% of the values), the whiskers are the highest and lowest values (excluding outliers), and the line is the median, n=5-18. Medians without a common letter differ, P <0.05.
TREATMENT AT CREN ALLOWED RECOVERY OF:

• STATURE AND WEIGHT
• INSULIN PRODUCTION AND SENSITIVITY
• BODY FAT AND LEAN MASS (ESPECIALLY IN GIRLS)
• BONE MINERAL DENSITY
• LEPTIN CONCENTRATION
• CORTISOL STRESS RESPONSE
• AND LONG-TERM NUTRITIONAL EDUCATION WITH INCREASE IN PROTEIN AND IRON CONSUMPTION

Let us unite our efforts to fight malnutrition and stunting!

1% increase in population height leads to 2.4% increase in earnings