



Children, chickens, eggs, environmental enteric dysfunction and Campylobacter: the CAGED study

Arie Havelaar, University of Florida, Gainesville, FL

Photos: UF IFAS, African Chicken Genetic Gains, Rod Waddington, Reuters









STUNTING

- Affects 25% of children globally, 35% in Africa, 38% in Ethiopia
- Stunting is associated with:

>Increased mortality from diarrhea, pneumonia, other infectious diseases

>Impaired cognitive development

>Reduced income (by up to 22%)

Reduced life expectancy by up to 17%
Increased risk of chronic diseases later in life

 Need for interventions to reduce this important cause of morbidity and mortality











FOR NORMAL GROWTH AND DEVELOPMENT 3 CONDITIONS MUST BE MET

No excess of symptomatic common infections such as malaria, diarrhea, or lower respiratory tract infections



Diet provides adequate macro- and micronutrients in bioavailable forms

> Dr. Mark Manary Washington University, St Louis









USAID

PONAL DENE

THE VICIOUS CYCLE OF DISEASES OF POVERTY







ENVIRONMENTAL ENTERIC DYSFUNCTION

- Develops in the first three years of a child in developing countries.
- It is characterized by a chronic inflammation of the small intestine, abnormal villous architecture and reduced intestinal mucosal surface area.
- Etiology of the disease is complex, it is associated with unsanitary living conditions, colonization by intestinal pathogens and malnutrition.









NUTRITIONAL INTERVENTIONS TO REDUCE STUNTING

- Micronutrients and plant-based foods have significant, but modest effects; typically 0.2 – 0.3 LAZ
- Animal source foods

Best available sources of high-quality nutrients: proteins, vitamins (A, B12), zinc, iodine, iron, choline, docosahexanoic acid; high bioavailability lannotti et al., Am J Clin Nutr. 2017;106:1482-1489: in Ecuador, providing one egg a day to children 6-9 months of age for six months increased LAZ by 0.63 and reduced stunting by 47%



- No nutritional intervention alone has fully prevented stunting
- Additional control of infectious disease agents is needed









HYGIENE INTERVENTIONS TO REDUCE STUNTING

- WASH Benefits (Luby et al.,; Null et al., Lancet Glob Health 2018)
 - Cluster randomized trials in Bangladesh and Kenya
 - Can WASH and nutritional interventions prevent early life linear growth faltering?
 - Are combined WASH interventions more effective than single interventions?
 - Are there synergistic effects on diarrhea or linear growth?
 - Nutrition improved linear growth by 0.15 0.20 LAZ; no additional effects of WASH
- SHINE (Clin Infect Dis 2015;61:S685-S702)
 - Cluster randomized trial in Zimbabwe
 - Independent and combined effects of improved household WASH and nutrition on length and hemoglobin concentration among children at 18 months of age
 - Nutrition improved linear growth by ~ 0.20 LAZ; no additional effects of WASH
- Can exposure to animal excreta explain the limited effects of WASH?









ETHIOPIA LIVESTOCK MASTERPLAN

- In order to meet the increasing demand and nutritional need for animal source foods, the Livestock Master Plan (LMP), adopted by the Growth and Transformation Plan (GTP) of the GOE in 2015, aims to significantly increase poultry production by moving from traditional (scavenging) family poultry to improved (semi-scavenging) family poultry systems (IFP).
- In all production zones, the LMP envisions increases of 250% between 2014 and 2020 in the number of IFP keeping households (egg and meat production)
- The LMP may provide improved access of pregnant mothers and young children to animal source foods with nutritional benefits
- Higher poultry densities may negate the nutritional benefits through increased exposure to infectious disease agents in chicken droppings









ANIMAL OWNERSHIP, CHILD GROWTH AND ENVIRONMENTAL ENTERIC DYSFUNCTION

- Relationships between animal ownership and child growth are complex
- Several studies report net beneficial effects
- Beneficial effects can be reduced or even negated by exposure of children to animal feces
 - Headey et al. (2016) Ethiopia
 - Poultry ownership beneficial; poultry but not larger animals in home overnight detrimental
 - Headey et al. (2016) Ethiopia, Bangladesh, Vietnam
 - Negative association between HAZ and visible animal feces in BGD and ETH, but not in VNM
 - Ngure et al., 2013 Zimbabwe
 - Of 23 children, 3 ingested soil and 2 chicken feces in a 6-hour period
 - George et al. (2013) Bangladesh
 - Animals in child sleeping rooms associated with increased markers of environmental enteric dysfunction









CAMPYLOBACTER AND STUNTING

- MAL-ED study
- 24-month length-for-age Z (LAZ) score associated with:
 - Complementary food (+)
 - Diarrhea (-)
 - Colonization by specific enteropathogens (-)

Low Diarrhoea and Pathogens + High Complementary food High Diarrhoea and Pathogens + Low Complementary food

Low Pathogens

High Pathogens

Low EAEC

High EAEC

Low Giardia

High Giardia

Average

Low Campylobacter

High Campylobacter

GATES foundation





The work here suggests modifying the longstanding Unicef framework of malnutrition by adding enteropathogen infection in the absence of diarrhoea.

FROM THE AMERICAN PEOPLE

Platts-Mills et al.. BMJ Glob Health 2017; 2:e000370 BILL& MELINDA II RI III TEITEA







EXPOSURE TO CAMPYLOBACTER

- Chickens and other livestock are major reservoirs of human exposure to *Campylobacter* globally
- Transmission may occur by food, direct animal contact or environmental contamination
- Relative pathway contributions varies by settings; foodborne transmission more important in industrialized countries
- Very few data available for (children in) low and middle income countries
- Irrespective of transmission pathways, controlling reservoirs is expected to lead to reduction in (asymptomatic) colonization









ASYMPTOMATIC CAMPYLOBACTER INFECTIONS ARE HIGHLY PREVALENT











VISION

- Research has shown that young children who eat chicken eggs grow better and gain life-long benefits
- Our research in Ethiopia tests the benefits of improved poultry production by smallholders aiming to produce more eggs for their children
- We also examine the advantages of protecting their children from chicken droppings by using coops, which should further improve health and growth of the children













HYPOTHESES

- Against a background of increased chicken production by smallholder farmers, (a)symptomatic colonization with *Campylobacter* bacteria of children between 6 and 18 months of age will be reduced by limiting their exposure to chicken excreta through animal husbandry interventions and hygiene training
- Reduced colonization by *Campylobacter* bacteria will reduce the prevalence of environmental enteric dysfunction in children, and, in combination with improved access to eggs within the household and basic nutrition and WASH training, will increase linear growth among children between 6 and 18 months of age











CLUSTER RANDOMIZED CONTROLLED TRIAL

- Three treatment arms, hierarchical random approach Random allocation of kebeles to treatment arm Random selection of children in kebele 100 children per treatment arm; power calculation updated after formative research
- Full treatment

10 chickens of exotic breed (White Leghorn) in movable poultry house; vaccinations, health care, feed

Neighboring families receive 5 chickens in movable houses

Nutritional and hygiene training

• Partial treatment

As full treatment, no movable poultry houses

Control



Current situation – scavenging chickens of traditional breed, often kept in the home overnight









STUDY AREA – HARAMAYA WOREDA, ETHIOPIA











FORMATIVE RESEARCH - ETHNOGRAPHIC

- March-May 2018
- Objectives
 - Understand local community contexts, socio-cultural beliefs and practices and social organization in relation to poultry, dietary intake, WASH, and child growth as they pertain to Campylobacter epidemiology
 - Explore community-level opportunities and barriers to possible interventions aimed at improving poultry biosecurity and zoonotic disease prevention, with a specific focus on caging poultry
- Methods
 - Informal rapid ethnographic approach, weekly visits
 - Animal feces, poultry management, poultry interventions, food safety, child health and growth, child nutrition and care, WASH, gender roles and community organization, poultry development projects, livelihoods and environmental change









VILLAGE CHICKEN PRODUCTION

- Chickens are the domain of women, though there is interest among young men
- Chickens produce four economic benefits: through eggs, chicken meat, the sale of roosters and fertilizer
- Households keep local indigenous chickens
- Land pressures make chicken production more attractive, although the lack of feed is problematic
 - Exotic breeds (White Leghorn, Fayoum) introduced more than 50 years ago, well accepted, productive, interbreed
 - Improved breeds: Bovan Brown (~10 yrs) and Sasso (~1 yr)
 - Not adapted to scavenging lifestyle due to appetite, predators, reproductive problems, and taste of eggs
 - Locally known as the *jazba* (confused) breeds
 - Potential for scaling up production



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INITIAL RESULTS

• All results in this presentation are preliminary and cannot be shared publicly at this time













CONCLUSIONS

• These are preliminary and cannot be shared publicly at this time









STUDY TEAM

• University of Florida, Gainesville, FL

Arie Havelaar, Sarah McKune, Kevin Bardosh, Yang Yang, Greg Kiker, Matthew Robinson, Nitya Singh, Billy (Dehao) Chen

• Haramaya University, Harar, Ethiopia

Jemal Yousuf, Abdulmuen Mohammed, Negasi Ameha, Mengistu Ketema, Kedir Teji, Nega Assefa, Abdulmuen Mohammed, Jeylan Wolie, Elias Ahmed, Ibsa Abdusemed, Jafer Amin, Ibsa Usmane

Ohio State University, Columbus, OH

Wondwossen Gebreyes, Getnet Yimer, Gireesh Rajashekara, Loic Deblais, Emia Oppenheim

- Washington University in St. Louis, MO, USA Mark Manary, Isabel Ordiz
- Food and Drug Administration, College Park, MD Marc Allard
- Massey University, Palmerston North, New Zealand
 Nigel French, Jonathan Marshall











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